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POLLUTION OF LAKE SUPERIOR AND ITS TRIBUTARY BASIN, MINNESOTA-WISCONSIN-MICHIGAN. PROCEEDINGS OF CONFERENCE HELD AT DULUTH, MINNESOTA, ON MAY 13-15, 1969. VOLUME 2

Federal Water Pollution Control Administration
Washington, D.C.

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Duluth, Minnesota
Executive Session
September 30-October 1, 1969
Duluth, Minnesota

CONFERENCE

Pollution of Lake Superior and its Tributary Basin, Minnesota-Wisconsin-Michigan

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9:00 a.m., Wednesday, May 14, 1969

P R O C E E D I N G S

Mr. Dominick: The conference will come to order.

I understand that we had some difficulty yesterday with the microphones in the back of the room. If anyone has any difficulty in hearing today, please notify us up here at the head table so that we can have the microphone adjusted.

We will hear first this morning from Mr. John Heritage, who is representing Senator Gaylord Nelson.

Mr. Heritage.

STATEMENT OF THE HONORABLE GAYLORD NELSON,
UNITED STATES SENATE
WASHINGTON, D. C.
(Read by JOHN HERITAGE, LEGISLATIVE DIRECTOR
OFFICE OF SENATOR NELSON)

MR. HERITAGE: The Senator wanted very much to be here toady, but he can't. The doctors told him that he has a virus infection, which is similar to one he had 2 years ago that kept him in bed 2 weeks, and ordered him to bed.

As you know, he is very interested in the deliberations and the conclusions of this conference.

He has prepared a statement. I will submit the statement for the record in its entirety, and will read portions of it.* So I will proceed. Thank you.

---

* Statement follows in its entirety.

Honorable Gaylord Nelson

Mr. Chairman, conferees, and ladies and gentlemen:

One of the most serious and pervasive "by-products" of American progress has been the pollution of almost every major body of water in this country by wastes of all kinds, colors, shapes, and smells.

We have polluted rivers in our urban areas so badly that in some cases they are fire traps. But we have also polluted waters in the most remote areas of the country. This is exactly what is threatening now in some portions of the Boundary Waters Canoe Area.

For decades we have hidden our eyes and hoped the growing pollution problem would go away. But in recent years it has been too obvious and too gross to ignore. In fact, water pollution has generated a national concern that with each succeeding year is more insistent on immediate and effective action.

In our own region we have seen the voters of both Wisconsin and Michigan support bonding issues in the hundres of millions of dollars to fund pollution cleanup. And we have all seen the intense citizen interest in Minnesota, Wisconsin and Michigan over the fate of Lake Superior. Since its formation in February, 780 people have joined the Save Lake Superior Association.

It has been gratifying to see the results when the people really speak out, as they have on the pollution issue. Under precedent-setting Federal acts, water quality standards have been set and Federal-State enforcement conferences have been held all over the country in a national effort to stem the tide of pollution.

Honorable Gaylord Nelson

Already 45 Federal-State conferences have been held to abate the pollution of interstate waters from Boston Harbor, the Potomac River and Lake Erie in the East, to Lake Michigan and part of the upper Mississippi River in our region, to Puget Sound and the Snake River in the West.

But perhaps the most important enforcement conference yet is the one we are undertaking here this week to abate and prevent pollution of Lake Superior. The conference was called by former Secretary of the Interior Stewart Udall after I had for several years been urging such action either by the Governors or by the Secretary.

It is no small question, no minor concern. The dimensions and the values of this natural resource are almost without parallel.

Let me describe Lake Superior in terms of what it means not only to us but to this country and to the world.

By volume it is the third largest body of fresh water on earth, almost 3,000 cubic miles. Only Lake Baikal of Russia and Lake Tanganyka of Africa are larger.

The shoreline of the lake stretches 2,976 miles, and is perhaps Lake Superior's most precious asset. The three States share 1,427 miles of the shore; Ontario, Canada, has 1,549 miles, making it truly an international lake.

The Federal report does a good job of describing the sweep of the shoreline: "The wide sand beaches of Whitefish Bay, the great perched dunes near Grand Marais, the sheer cliffs of the

Pictured Rocks, the remoteness of the Huron Mountains, the Apostle Islands, Split Rock Lighthouse, Isle Royale National Park, and all the many miles of primeval wilderness constitute a most valuable recreation and aesthetic resource."

But words aren't adequate for the feeling one has standing on that ancient shore, sensing the whole history of the earth unreel in the rocks, the cold waters, the fog of even a summer morning. One gains an impression, then rather humbly, of the forces that created man, the same forces that can just as easily sweep him away.

Lake Superior is pure as well. So pure one can see a trout at depths of up to five fathoms. So pure the National Water Quality Laboratory was located near Duluth in good part because this is one of the few places where they would not have to import water clean enough for their baseline work.

I should add parenthetically that the North Shore is an especially fitting location for this national fresh water laboratory for another reason, it is in the District of Congressman John Blatnik, who has been one of the most ardent and effective advocates for clean water in this country. No one in the Congress has been more dedicated and effective in the cause of protecting the quality of our public waters than John Baltnik and we owe a great deal to him for the very Federal statutes which authorize conferences such as these.

On the North American continent there is simply no body of water to compare with this lake, in volume, in purity, in value.

And left to its own devices, with its small drainage basin and infertile rock, Lake Superior would remain pure for thousands of years, unchanged, almost ageless.

Yet experience has shown us that there is little reason for comfort about the future of any resource in the world, especially in this age of expanding population, cities, industry, and technology.

Lake Baikal, almost twice the volume of Superior, has pollution problems, primarily from the wastes of several big industries.

We are even on the way now to polluting the oceans. Our progress is marked by the newspaper reports about oil spills, red tides, poisoned shellfish, and Antarctic penguins with DDT in their bodies.

Call the roll of lesser but still impressive bodies of water, Switzerland's Lake Zurich, Wisconsin's Lake Mendota and Lake Menoa, New York's Lake Cayuga and Lake George, Florida's Lake Okeechobee, or of the hundreds of inland lakes in the Upper Midwest and nationwide that are often so thick with algae they are like pea soup. They are severely polluted, and it will take decades and millions of dollars to restore them. Or of the hundreds of inland lakes in the Upper Midwest and nationwide that are often so thick with algae they are like pea soup. They are severely polluted, and it will take decades and millions of dollars to restore them. Or the Great Lakes less than two centuries ago explorers and settlers of this region found the lakes remarkably crystal clear and pure. In effect, five Lake Superiors.

But gross pollution is winding its way rapidly up the chain.

Lake Erie is a dying lake. Game fish are on the way out. Municipal and industrial wastes have closed bathing beaches from Detroit to Cleveland. The stench from rotting algae can be smelled for miles around.

Lake Michigan is on the way. Severe pollution is occurring in the southern end, in the Green Bay area, and along the shoreline. The lake's fishery has suffered the scourge of the lamprey and the alewife, both introduced from the sea by man's action. Now the pesticides DDT and dieldrin have concentrated in the lake to such high levels that they threaten sports and commerical fishing.

Lake Ontario is suffering the same destruction as Lake Erie, where it gets 85 percent of its waterr

Trouble spots have shown up on Lake Huron, especially near heavily populated areas.

These Great Lakes, once a magnificent example of the works of nature, are now a sad monument to the follies of man.

And it can happen on Lake Superior.

The Federal report points out the delicacy of this body of water, its clarity is extremely susceptible to being reduced by pollutants. Addition of a few parts per billion of heavy metals will have lasting deleterious effects on the lake. Sedimentation will damage fish spawning areas, which are already limited by the nature of the lake. The deep blue color, valuable aesthetically and for tourists, can be changed by tiny particles in suspension.

"The quality of Lake Superior is so high compared to other lakes that the early signs of damage may go undetected or may be excused as being insignificant," the report says.

Small changes wrought by man will set off a chain of events that could change this lake beyond present recognition. In more ways than one, it is clear that this giant of a lake has an Achilles Heel. It is a Goliath that can be slain by a David, though I doubt the event would be remembered as one of our heroic feats.

Maybe it would qualify, though, for Ripley's "Believe it or not".

Or maybe we could say, "We've finally moved this region into the mainstream of progress. We've polluted Lake Superior." Not too long ago in America that was the attitude, and it was once tolerated.

We haven't by any means polluted this lake yet. But the danger flags are up:

Municipal wastes are being discharged directly into the lake or into the drainage basin from 93 cities, towns, and districts. In many cases treatment is at the outmoded primary level, or is nonexistent, although pollution control programs of the three States are under way and, if followed, will improve treatment.

Industrial wastes are being discharged from 61 industries. In many cases, control is nonexistent or completely inadequate, and for some sources abatement schedules have not yet been set by the

States. I urge that such schedules be set as quickly as possible so pollution from these sources can be eliminated.

Wastes are also being discharged from Federal installations and facilities. Here again controls are in instances completely inadequate, and it is critical to the integrity of the Federal program that the pollution be stopped.

Erosion in northwestern Wisconsin's red clay area has damaged valuable trout and recreational streams, discolored Lake Superior waters off the south shore of the lake, and is damaging the lake's aquatic life. I urge State and Federal officials to initiate a major program of soil conservation and stream bank stabilization on south shore streams and watersheds, based on recommendations of the Red Clay Committee. I will reintroduce legislation shortly which would aid in this effort.

Hundreds of commerical, sports and Federal vessels are dumping untreated wastes directly into the lake.

The U. S. Army Corps of Engineers continues to contribute to pollution by dumping its harbor dredgings into the lake. Last year the Corps dredged 1 million cubic yards from harbors in Lake Superior and dumped most of it in open water. It is urgent that current Corps studies and hearings produce results shortly.

As in any other major shipping or industrial area, Lake Superior faces the continued danger of disastrous oil leaks and spills, the effects of which we saw recently at Santa Barbara.

Honorable Gaylord Nelson

On the Canadian side, there are indications that both American-owned-and-Canadian paper mills are discharging untreated effluent directly into the lake. Effective protection of Lake Superior will require international cooperation, and perhaps international agreements, which I hope this conference will study and recommend.

For pollution sources on the American side, the Federal report makes 20 recommendations. Most are excellent, and some are precedent-setting in their acknowledgment that Lake Superior is a priceless national heritage not only for us but for future generations.

For instance, the report recommends some of the strictest interstate water quality standards in the history of the national program.

With two exceptions, I concur wholeheartedly with this and the other recommendations of the report, and urge their adoption and immediate implementation by the conferees.

The exceptions are important ones.

First, I urge that upgraded standards as strict as those proposed by the report for Lake Superior itself eventually be set throughout the entire drainage basin. The conferees should adopt long-range timetables to accomplish this.

I don't believe any other course will assure long-term protection of the unique water quality of the lake.

In some instances, lower quality standards, such as "limited body contract," are being set for portions of rivers entering the lake. Examples of this are sections of the Montreal and

St. Louis Rivers. This means that improved but still lower quality waters will continue to be fed into the open lake, possibly setting off the kind of chain reaction which could seriously alter the ecology of Lake Superior.

The upgraded standards should require that in time wastes discharged anywhere in the basin must be first treated to the highest degree technology will reasonably permit, or be disposed of elsewhere.

Further, such standards should as a general rule prohibit the discharge of significant new volumes or kinds of wastes into the basin.

Only in this way can we assure that the new industries and the new or expanded communities which are ligitimate parties in the sharing of this resource will not, with existing users, damage it beyond use for all.

If we hesitate on such standards, it is inevitable that as the population of this region increases, we will be faced over the years ahead not with a trickle of pollutants, but with a deluge.

A sample is the gaseous diffusion plant which has been discussed for a location 20 miles from here near the Lake Superior shore. In producing fuel for nuclear power reactors, this massive plant reportedly would use more than 2 billion gallons of Lake Superior water a day, and return it heated to the lake.

Thermal pollution has become a national issue, as we learn more about the serious effects of heating our lakes and streams.

Honorable Gaylord Nelson

Nowhere is there greater cause for concern than in this region. On Lake Michigan alone six nuclear power generating plants will be in operation by 1973. If power industry growth continues at its present rate, the result will be an increase by several degrees in the temperature of the entire lake. Not one of the plants is installing systems to cool the water before it is discharged back into the lake or is planning to ship away all liquid radioactive wastes.

No nuclear power facility of any sort, including the gaseous diffusion plant, should be allowed to operate on Lake Superior or in the drainage basin unless it eliminates all heat and radioactive discharges that technology will permit. A nuclear power generating plant in Sacramento, California, is being designed to discharge no heat and no radioactivity into the water.

Standards such as these are not without precedent. The State of New Jersey has set similar ones on several of its valuable fresh water lakes. And there is a total prohibition against discharge of any wastes into Lake Tahoe.

Second, it is a matter of serious concern that the Federal report does not make firm recommendations for action now regarding Reserve Mining Company's discharge of taconite tailings at Silver Bay.

I think there is ample evidence that action in this matter is justified and necessary for protection of Lake Superior.

Since 1956 more than 190 million tons, or 380 billion pounds of taconite wastes have been put into the lake.

One year of Reserve's tailings discharge nearly equals 30 years of natural discharge of sediments by all United States tributaries to Lake Superior.

If, as scheduled, the plant operates at current levels for the next 40 years, it will put into the lake one trillion, 881 billion, 600 million pounds.

If, as is possible with Reserve's ore body, the plant operates for the next 90 years, the total tailings going into Lake Superior from Silver Bay would reach 4 trillion, 233 billion, 600 million pounds.

In northern Wisconsin, we have taconite ore reserves on the Gogebic Range, which a gross estimate shows reach 1,000 million tons for the first 100 feet. This means we could discharge 1 or 2 trillion more pounds of taconite tailings into Lake Superior from the Wisconsin side if a similar plant were built there.

Where would it end?

I believe this artificial discharge of massive amounts of material into the lake is a pollutant and is bound to have serious and possibly catastrophic long-range consequences.

For instance, one of the specific conclusions of the Federal report is that the tailings are already damaging the ecology of a portion of the lake.

The report also accepts conclusions of an earlier Interior Department task force report which found that the tailings are affecting critical lake values, such as the low mineral content, extreme clarity, limited fish spawning grounds, and the deep blue color of the water.

Furthermore, the report contains evidence found just last month that tailings are now present in the drinking water supplies of Beaver Bay and Two Harbors, and in Duluth, some 50 miles downshore from the Silver Bay plant.

Not only does this raise public health questions but it makes it almost inevitable that the tailings have moved to the Wisconsin side.

If there isn't adequate authority for action to properly control this massive tailings discharge, I will ask that Congress amend the pollution control laws.

However, there are a number of authorities already available to the conferees, and with the full support of the Governors of all three States there appears to be little question that appropriate State and Federal action could be taken where necessary.

First, the Minnesota permit for the Reserve operation states that tailings outside a 9 square-mile zone in front of the plant should not cloud or discolor the water, affect fish life or public water supplies, interfere with navigation, or cause any public nuisance. I believe the discharge has exceeded terms of this permit.

Second, the Lake Superior water quality standards of both Minnesota and Wisconsin prohibit artificial discharges which will cause nuisance conditions. The standards also cover toxic and other damaging materials and involve both State and Federal authorities.

Third, by interdepartmental agreement the Army Corps of Engineers' permit for the Reserve operation must consider pollution, and the permit is now under review pending the recommendations of this Conference.

I understand from reliable reports that in recent weeks the Federal Water Pollution Control Administration has taken bottom samplings on the Wisconsin side of Lake Superior and has found that they contain taconite tailings. This makes it clear that pollution of interstate waters is being caused by Reserve Mining Company's tailings disposal at Silver Bay, and settles the dispute over the question of whether this conference has jurisdiction over Reserve's operation.

It would be unfortunate if, with the evidence and with the authorities available, the conferees were to accept a recommendation calling only for continued surveillance.

Alternative means for disposal of the tailings must be extensively explored, and an early report must be made back to the conferees for their consideration and decision in the near future.

The same technological ingenuity which produced the marvel of the taconite process must be put to work to prevent pollution by the taconite wastes.

Substantial costs will be involved.

But to cite just one example, United States Steel Corporation has spent $235 million since 1950 for air and water pollution control at its facilities around the country, including its Iron Range plant. U.S. Steel currently is spending $50 million a year on these problems, and just 2 weeks ago announced major new control steps.

When costs are considered, the conferees should also look at what society will pay in damages to the recreational asset Lake Superior offers for the entire Nation, and in damages to the commerical fishing industry.

The damages will also be charged against Lake Superior's great potential as a source of clean water for the mid-United States, which faces some water shortages for all uses in the next few decades.

But even more than this, American society would be losing a natural resource that is a treasure and a heritage for all time. The quality of life for all Americans would be diminished by it. The difficulty in putting a price tag on this loss does not diminish its importance at all.

I believe it is time this Nation established a policy that says pollution control must be a part of doing business.

This is an ethic which I believe the American people strongly support and which business must accept, and, in fact, is accepting.

It is time we said: No one has a right to pollute the air, the water, the land. It belongs to us all and must not be used for the special benefit of any community or company or individual. There is no better place to start than on this lake, which is uniquely well qualified for the very best protection we can give it.

Honorable David Dominick

Mr. Dominick: Thank you very much.

I think it would be appropriate for me to clarify certain points which have been raised since the beginning of this conference.

The Federal Water Pollution Control Administration presentation at this conference has been based upon the material we have prepared and set forth in our report entitled "An Appraisal of Water Pollution in the Lake Superior Basin." The information contained in this report and presented orally by Federal Water Pollution Control Administration personnel has been fully analyzed, documented, and evaluated in accordance with our standard procedures. In a word, this information which is fully supportable in the opinion of our staff, and, as Dr. Donald Mount testified yesterday, this is information which the Federal position can, quote, "stand on," end quote.

In the normal course of our investigations into the water quality of Lake Superior, continuing water sample studies are being conducted by National Laboratory personnel here in Duluth. Questions such as the distribution of taconite tailings in the waters of Lake Superior, the presence of taconite wastes in interstate waters of Lake Superior and the pollutional effect of such wastes in such waters - these questions are obviously of critical importance to the Federal Water Pollution Control Administration, to the conferees seated here, and to the continuing future actions of the Lake Superior conference.

At the present time the water sample studies which I have mentioned have not been fully analyzed, documented, or evaluated in the judgment of responsible Federal scientists. So from both a scientific and legal point of view, it would be inappropriate to consider these raw samples in the context of this conference at this time. The critical questions which I have mentioned will require much further study, full analysis and evaluation of evidence before satisfactory answers can be offered. As proper evidence is obtained and evaluated on these questions, this will be made available as is always the case with such information to this conference and to the public.

I have a telegram here from Walter F. Mondale, United States Senator, which I ask be placed in the record at this point.

MR. MERRITT: Are you going to read it, Mr. Chairman?

MR. DOMINICK: I would be happy to read it.

MR. MERRITT: Please. (Mr. Dominick reading)

May 13, 1969

I today repeat a plea made earlier to Governors Levander of Minnesota and Knowles of Wisconsin to conferees at the Lake Superior conference:

1. That conferees act decisively to save a priceless natural resource, Lake superior, for this and future generations;

2. That the Governors of Wisconsin, Minnesota, and Michigan endorse this conference and the full use of its authorities;

3. That the conferees identify all sources of pollution, whether intrastate or interstate in character; and that State and Federal authorities act promptly to end pollution of Lake Superior.

Honorable Walter F. Mondale

Two official Department of Interior reports, one issued in January, a second last month, have identified sources polluting Lake Superior. It is essential that all sources polluting the lake be stopped. In order to make certain this is done, we must have available for use all possible authorities whether they be Federal, State or local, so that pollution by any definition is dealt with.

Of the five Great Lakes, Erie is near death; three others are seriously polluted and remedial actions will take decades; if indeed remedies for the pollution affecting them can be found at all.

Of the five only Superior is relatively healthy. It will not long remain so if we fail to stem pollution before its effects become irreversible.

I strongly urge the conferees to act on the basis of the two official reports; and to use the authorities available on all levels of government to stop pollution from all sources.

I will appreciate your inserting my comments in the conference record.

Signed, Walter F. Mondale, U. S. Senator.

MR. MERRITT: Thank you, Mr. Chairman.

MR. VOGT: Mr. Chairman, you indicate the staff has some additional information regarding samples and the like and that you are collecting additional information, apparently, all the time, and that you are in the process of evaluating this data and that this will be reported to the conferees at some future time. At what time would you estimate that this additional data would be available, not only the data, but your evaluation or your staff evaluation?

MR. DOMINICK: I am not able to give you a time estimate at the moment. These studies are going to have to be done on a continuing basis. Sufficient evidence will have to be obtained, and I am not prepared as a layman to discuss with you the amount of time that this would take.

MR. VOGT: Well, then, do you think that conclusions can be arrived at here by the conferees as far as this conference is concerned on this point?

MR. DOMINICK: I think that I made it clear in my statement. If I did not, I will clarify it now, that the Chairman believes that this conference at this stage should confine itself to the information which has been gathered, analyzed, and fully evaluated and presented both in the report, which we have before us, and orally by Federal officials. In other words, we have to have a specific body of information before us for the conference to act in accordance with the recommendations that we have before us.

MR. VOGT: Are you saying, then, that as additional information is placed before the conferees any decision that might be arrived at on the basis of current data might be altered?

MR. DOMINICK: I am saying that in accordance with the recommendation we have before us we will be holding progress meetings on a 6-month basis and that the continuing surveillance which has been recommended will be presented at these progress meetings and any future action which the conferees mutually decide as appropriate will be taken.

MR. VOGT: I think we in Michigan have similar concerns as expressed by Senator Nelson in his statement about the taconite ore reserves in northern Wisconsin and what might happen as far as Wisconsin as far as these discharges, should they be permitted to occur there.

MR. DOMINICK: Very good.

MR. VOGT: As any Federal action or any other action might be taken with respect to dsicharges in Minnesota.

MR. DOMINICK: Very good. I think all of these things will be before us on a continuing basis as this conference proceeds into our progress meetings.

MR. BADALICH: Mr. Chairman, it is, then, my understanding that the material at this particular conference will be the basis for our conclusions and recommendations etc.?

MR. DOMINICK: That is correct.

Mr. Badalich, are you prepared to go forward now?

MR. BADALICH: Yes.

MR. DOMINICK: We did have a request from Mr. Frangos to question Dr. Bartsch for a short period of time on his testimony yesterday.

Mr. Frangos.

MR. FRANGOS: Thank you, Commissioner.

While Dr. Bartsch is coming up here, I would like to indicate Mr. Voigt has returned to Madison because of our Department Board is meeting the next several days. I ask Mr. Ted Wisniewski to sit and participate as conferee from Wisconsin.

I also note for the record that Dr. Bunch has provided me with the information that I asked for yesterday relative to operating costs for nutrient removal at municipal plants. He submitted a copy of his brief summary for the record. I would note in the information probided by Dr. Bunch that he indicates that for a plant of the size of 10 million gallons per day, which would serve a population of some 100,000 people, capital costs for providing nutrient removal is $1.6 million. Operating and maintenance costs translate to .7¢ per 1,000 gallons, which means $700 a day or $252,000 a year.

I understand, Dr. Bartsch, you will be leaving so I will take a couple of minutes to ask you several questions.

What I would like to ask you is, on the basis of your excellent report to us yesterday, I am wondering if you could tell me if we go ahead and require 80 percent removal of phosphorus from municipal point sources in the basin, what will we buy by this action?

Let me put it another way. I noted in your statement it says, "It makes no difference where along the time scale such increasing human influence is brought to bear, the end result is always the same." Perhaps, what I am asking you is could you tell us where we are on the time scale today for Lake Superior?

DR. BARTSCH: I don't believe, Mr. Frangos, that there has been enough study done so far on Lake Superior to permit anyone to put a finger precisely on the point along this time scale that we have both now referred to. I think we have to go back to something which has been said here many times in this conference by many people, and that is that first we have a lake in Lake Superior which is of such beauty and splendor that everyone who is really serious and zealous about this wants to keep it that way. So I think we have to recognize from basic knowledge available generally from observations throughout the world that if you start with a lake like this, and if you permit the input of nutrients and supervising the input from the things people do on top of the natural input, history shows sooner or later you get into difficulties.

In terms of Lake Superior, I am not prepared to say that 80 percent now is the exact needs that we have. It may be even more than that. We know from the limited observations on phosphorus levels that we are already at levels which we know in many lakes are right at the point of causing trouble.

I said yesterday that this level on the average is in the neighborhood of 0.01 mg/l (one-hundredths of a milligram per liter) and in Lake Michigan we see [illegible]bblings along the edge that this is enough in a lake which is not too different fundamentally from Lake Superior to be at this point.

I think on the basis of this my view is, and in view of the fact once you put nutrients in excess in this lake, you can never get them out. It is not really a question of whether now we should take out 80 percent but a need to recognize that we have to keep out every bit of the nutrients that are going into this lake.

We talk about municipalities solely because that is something which is manageable. We have talked about the dollar costs and they are manageable. I think we also have to consider, as

I pointed out yesterday, that this may not be enough in the long haul. Maybe for a hundred years we will get by simply by being concerned with municipal and industrial sources, whatever they may be. But I am sure in my own mind somewhere along the line in the future we may be forced in saying how do we control the other diffused inputs for the entire watershed.

I apologize for not being more precise than that, but I think this is about where we stand with respect to this matter.

MR. FRANGOS: I think what I am trying to bring out is we are dealing in precise language.

Let me ask you this question. You talk about perhaps a hundred years, and we have recommendations for providing for the phosphorus removal by 1972 or 1973 if we use the time tables. What would a 3 year difference, let's say in 1977, make along this time scale?

DR. BARTSCH: Again we have a philosophical question here. If I were to express my own sincere personal feelings, I would say I would rather see it taken out tomorrow. But when we look at the fact that this lake has been in existence for some 12,000 years, more or less, I am sure that if someone would say we would take it out by 1977 I would not be too optimistic that I would quibble.

MR. FRANGOS: Really, what we are saying is we are taking some concrete action to protect this lake for these generations to come that we talk about so often. We may not see any change within the next 10 or 20 years, but we are making an investment now to save the lake a hundred or two hundred years from now.

DR. BARTSCH: I think that is precisely the situation, and it is also the situation in Lake Michigan. I think humanity is moving forward when these things can be accomplished.

MR. FRANGOS: Thank you very much, Doctor.

Thank you, Commissioner.

I think this is an important point that should be made. I appreciate the time you gave me.

MR. DOMINICK: Thank you very much.

The State of Minnesota will now proceed with its presentation.

STATEMENT OF JOHN P. BADALICH
EXECUTIVE DIRECTOR, MINNESOTA
POLLUTION CONTROL AGNECY
MINNEAPOLIS, MINNESOTA

MR. BADALICH: Thank you, Mr. Chairman.

Fellow conferees, ladies and gentlemen:

Mr. Chairman, I regret that I don't have the statement in its final edited form. I will have it typed as soon as I am through. I will have it available for the conferees and the press and others who might be interested. I am sorry this happened. We made a few slight revisions during the course of the evening.

We appreciate the opportunity to participate as a partner in these proceedings with our counterparts from our neighboring States and the Federal Water Pollution Control Administration. Congressman Blatnik emphasized earlier at this conference the great wealth of technology and scientific data available to determine the exact origin of various types of pollutants and the exact effects they may have on the lake.

We urge the conferees to utilize this available technology to the fullest extent. If we use these tools wisely, then there will be no meaningful divergence of opinion and no controversy concerning the facts of Lake Superior regardless of who makes the investigation.

Lake Superior is an oligotrophic lake of low mineral content, extreme clarity and cold temperature. All agree that the the present water quality is excellent by any standard and by comparison with any other natural waters.

There is currently only a small discharge of anything other than inert wastes from Minnesota sources directly to Lake Superior. Significant quantities of reactive wastes are discharged to tributary waters but these sources have little or no deleterious effect on Lake Superior.

The St. Louis River below Cloquet is not yet considered to be of satisfactory quality. Substantial amounts of treated industrial wastes and sewage effluents are discharged from one pulp and paper mill, related wood product plants in Cloquet and Duluth, and from municipalities on tributaries to Lake Superior. All such wastes and sewage receive at least primary treatment or the equivalent, except for the sewage from one small village. In the reach of about 35 miles from Cloquet to Superior Bay the river recovers its former good quality prior to its entrance into Lake Superior. Studies for the purpose of providing further improvements are currently under way at all of these major sources.

Agreements have been reached with the several sources in the Cloquet area to expand treatment works to provide secondary treatment for these reactive wastes and schedules of performance have been established.

Unfortunately, although the Federal Government indicated five months ago that the agreements were satisfactory, we have not thus far been able to obtain formal approval of our Implementation Plan containing these agreements from the Department of the Interior and as a result we cannot now legally require the dischargers in the area to make these improvements.

Voluntary progress is known and reported to us in spite of the indecision of the Department of the Interior.

Minnesota has been troubled by water pollution that is incidental to the operation of vessels in the Seaway Port of Duluth as has been experienced in most other seaports. This has occurred from promiscuous discharges of raw sewage, refuse and dunnage from both foreign and domestic vessels. Minnesota has a law in effect controlling such discharges from pleasure boats and we believe it to be quite effective. We have, however, no practical way of controlling the discharges from federally-registered and foreign vessels.

Information on practical methods of control and assistance in enforcement from the Federal agencies responsible for such vessels will be most welcome.

Minnesota, through its Pollution Control Agency, has held a series of public hearings on water quality criteria and classification of our interstate waters. We gathered the best information available to insure that the criteria and classifications were adequate and proper to protect the health and welfare of the people of this State. Throughout this procedure we sought the advice of the Federal Water Pollution Control Administration and others who might be knowledgeable in the subject, so as to produce criteria adequate to protect all public uses of the water.

These particular waters were then classified in the highest category possible for surface waters under our system with the full concurrence of the Federal Water Pollution Control Administration.

The FWPCA report as presented at this conference recognizes that these standards promulgated by the Minnesota Pollution Control Agency are among the most stringent standards in the Nation, as was emphasized by Governor Levander yesterday.

Inasmuch as these are Federal as well as State standards, this conference should address itself to the primary questions of whether these established standards are being met and, if not, where and to what degree they are being violated.

The manner of water quality management at both the State and Federal level is established by law and cannot be subject to arbitrary and whimsical actions. The former provides for order and equity to all under the law; the latter for chaos and litigation. Therefore, we make the point that this must be a fact-finding conference as it was stated to be.

It is also clear that this conference is not a proper vehicle to set standards. It is in any case a quite unjustifiable procedure to attempt to revise the standards without having ever judged the adequacy of their worth or having determined if there has been or is a violation of them. If a violation is shown to exist, there then is a question of enforcement, and after that a revision of the standards is called for only if those we now have are shown to be inadequate.

We believe we can control all pollution of these waters utilizing the existing applicable standards.

Any action our agency might take in establishing standards or issuing permits or enforcement actions of various types is subject to appeal and attack in the courts. It is implicit in our legislative charge and in the public interest, that the actions of the agency can be upheld by the courts, and they will be if they are well founded factually and legally.

Minnesota has done a considerable amount of water quality sampling, monitoring, and studying of Lake Superior. The Minnesota Pollution Control Agency has conducted many studies prior to and subsequent to Reserve Mining's operation and have found the waters of Lake Superior to be of excellent quality. This information has already been made available to the Federal Water Pollution Control

Administration. Studies on fisheries and fish food organisms have been conducted by the Conservation Department and they will present a statement on their findings.

We are also certain that more information will be required and that further studies may be needed to resolve the questions raised. We recommend to this conference that if further studies are needed they should be undertaken by the International Joint Commission, United States and Canada. We pledge our wholehearted cooperation in this effort.

There is precedent for this action in Minnesota as we now have IJC references involving the Red and Rainy Rivers. There are also references involving the other Great Lakes and connecting channels.

These are, after all, not only interstate but international waters and if the problem is to be handled properly, that is, as a whole rather than piecemeal, we cannot ignore the role and interest of Canada in this body of water.

Regardless of how the waters of Lake Superior are to be administered, the Minnesota Pollution Control Agency will fulfill its responsibilities to the people of this State to the best of its ability. We want Lake Superior to remain unpolluted.

That is the end of my statement.

MR. DOMINICK: Thank you very much for your statement.

MR. BADALICH: Mr. Chairman, at this particular time the Minnesota Pollution Control Agency will present further evidence on all the discharge of the interstate waters. But I would like to deviate from this momentarily and call upon Mr. Robert Rygg, the

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Assistant Commissioner of Conservation, to talk about the studies the Conservation Department has made on Lake Superior.

MR. DOMINICK: Very well.

STATEMENT OF ROBERT RYGG,
ASSISTANT COMMISSIONER OF
CONSERVATION, MINNESOTA CONSERVATION
DEPARTMENT, DULUTH, MINNESOTA

MR. RYGG: Thank you very much, Mr. Badalich.

Mr. Chairman, this is the prepared statement of the Minnesota Conservation Department and copies of it are available to the Committee and we have extra copies for those who would like one at the conclusion of this session.

Lake Superior has had a long history of many uses extending back nearly 300 years. It has been a waterway for commercial traffic ranging from voyageurs, canoes carrying furs to great ore boats transporting the iron ore, which is a mainstay of the region's economy. The lake is an immense reservoir or pure water that is the domestic water supply of several cities. It has long supported extensive and high quality commerical and sport fisheries. Not least are its great recreational and scenic values. It also has received several kinds of wastes in varying amounts for at least a century.

Despite its many and varied uses it has remained one of the purest and cleanest large lakes in the world. It is a unique and magnificent body of water and the Minnesota Department of

Conservation intends to do all within its power to maintain it as such.

Pollution is a continuing and growing threat to all of the Nation's waters and Lake Superior is no exception. Our expanding population, increased standard of living, and greater demands on all natural resources all are resulting in ever increasing amounts of wastes. Many of these have been and still are being discharged into surface waters. There is mounting public concern and great efforts are being made at all governmental levels to preserve and where possible enhance the quality of our waters. A fine start has been made by setting of water quality standards for interstate waters, which include Lake Superior. These standards, which are set at the State level, have been approved at the Federal level. Efforts are now being made to meet these standards.

But it should be emphasized that Lake Superior is not only an interstate water, it is also an international water, and our ultimate goal should be to work with our Canadian neighbors so that all conditions that may adversely affect the lake receive consideration and both Nations thereby benefit.

Of the several kinds of wastes now received by the lake from many sources there has been considerable concern recently about tailings from taconite benefication on the Minnesota North Shore. Since the Minnesota Department of Conservation has involvement in both mining operations and water use, this statement will be chiefly concerned with taconite tailings and what is known about the effects on the lake. The Department has been collecting information on this for more than 20 years. Specifically, the plant concerned is the E. W. Davis Works of the Reserve Mining Company that is located on the shore of Lake Superior near Beaver Bay in Lake County, Minnesota.

On January 28, 1947, Reserve Mining Company made an application to the Commissioner of Conservation for a permit for appropriation of Lake Superior water for use in operating a taconite iron ore beneficiation plant and powerplant located on the North Shore in Lake County, Minnesota. The application also requested permission to return waters containing tailings from the plant operations to Lake Superior. Permission to return these tailings under laws in force at the time required approval of the waste disposal plans by the Minnesota Water Pollution Control Commission.

On May 9, 1947, an order for a public hearing on the application was made by the Commissioner of Conservation. Pursuant to notice, a series of nine public hearings were conducted by the Department of Conservation and the Water Pollution Control Commission. The initial hearing was held at Two Harbors, Minnesota, on June 5, 1947. Eight additional hearings were held during 1947 at Duluth and St. Paul. One thousand pages of testimony were received by the Commissioner as a result of these hearings.

The Commissioner of Conservation notified the Wisconsin Department of Conservation and the Wisconsin Water Pollution Control Board of the permit application and their representatives attended some of the hearings and advised the Commissioner that they did not object to granting the permits. Numerous other governmental agencies and conservation groups testified at the hearings.

Evidence presented at the public hearings included reports and findings on a number of tests of taconite tailings and their possible effects on Lake Superior and its environment. These included tests by the University of Minnesota, Mines Experiment Station; the Department of Conservation, Division of Game and Fish; University of Minnesota, St. Anthony Falls Hydraulic Laboratory; State of Wisconsin, Water Pollution Control Committee; a private consultant, Adolph Meyer; and Reserve Mining Company.

On December 18, 1947, after completion of the public hearings and an evaluation of all evidence and test data presented, the Commissioner of Conservation issued findings of fact, conclusions and order granting a permit to Reserve Mining Company for the appropriation of water for its mining beneficiation facility. The order further authorized the return to Lake Superior of wastewater and tailings from the plant operation.

The authorization for return of wastewaters and taconite tailings to Lake Superior was contingent on the following conditions:

(1) The material processed at the beneficiation plant come from a specific defined area in St. Louis County and shall contain only magnetic type taconite with no material amount of hematite or red oxide of iron.

(2) The taconite tailings discharged with wastewater shall not include any material amounts of water soluble or organic matter or any oil, sewage, or other waste.

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(3) The waste shall be discharged only into a designated area in Lake Superior, 3 miles wide and 3 miles long, adjacent to the plant.

(4) Such tailings shall not be discharged so as to result in any material clouding or discoloration of the water at the surface outside of said zone except during such time as turbidity from natural conditions in the adjacent portions of the lake outside of said zone may be caused by storms, nor shall such tailings be discharged so as to result in any material adverse effects on fish life or public water supplies or in any other material unlawful pollution of the waters of the lake or in any material interference with navigation or in any public nuisance outside of said zone.

To provide a continuing evaluation of plant operations and any effects resulting from the disposal of tailings in Lake Superior, a technical advisory board of State and company representatives was formed in 1948. This board included representatives of the Conservation Department, Water Pollution Control Commission, University of Minnesota, St. Anthony Falls Hydraulic Laboratory, and a company representative. Reserve Mining Company agreed to furnish some equipment and funds for the technical studies.

During 1948 through 1955 the technical advisory board made a series of tests and observations of the plant operation and of Lake Superior waters in the vicinity of the plant. These tests and observations included bottom sampling, turbidity and temperature measurements, bacteriological studies, air photo studies, lake current studies, weather data studies, Lake Superior North Shore tributary stream studies, biological studies of fish and fish food, and inventories of fish catches in the area. Investigations of fish catches, bottom studies, turbidity studies, and laboratory tests of suspended magnetic iron were made by State agencies and the company from 1955 to the present time.

The Conservation Department has been involved in many of the studies made of the plant and any effects it may have on Lake Superior and has cooperated with State and Federal agencies and Reserve Mining Company in evaluating and analyzing results of the many studies made.

To date there has been no evidence of violation of the conditions of the original permit, P.A. 47-12, issued in December 1947.

For the record I have attached to this statement a summary of hearings and orders for permits and amendments issued, and tabulation of reports and studies that have been made.

(The tabulation follows.)

APPENDIX 1

RESERVE MINING COMPANY TACONITE PLANT

Summary of Hearings, Order for Permit and Amendments Issued

Date	Subject	Remarks
1-28-47	Original application submitted	
5-9-47	Order for hearing made by Comm. of Conservation	
6-5-47	Initial public hearing on application	Two Harbors, Minnesota
6-17-47	Second public hearing on application	St. Paul, Minnesota
7-3-47	Third public hearing on application	St. Paul, Minnesota
7-11-47	Fourth public hearing on application	Duluth, Minnesota
7-22-47	Fifth public hearing on application	St. Paul, Minnesota
9-4-47	Sixth public hearing on application	St. Paul, Minnesota
9-30-47	Seventh public hearing on application	St. Paul, Minnesota
10-21-47	Eighth public hearing on application	St. Paul, Minnesota
11-4-47	Ninth public hearing on application	St. Paul, Minnesota
12-18-47	Notice of findings, conclusion & order P.A. 47-12	Authorized: (1) appropriation of 130,000 gpm of water from Lake Superior for use in taconite beneficiation plant and steam power plant; (2) appropriation of water from Lake Superior for domestic use in plant, approximately 1,000 persons - no appropriation limit; (3) disposal of waste water and tailings in Lake Superior.
12-22-47	Permit to discharge industrial water issued Water Pollution Control Comm.	Contains the exact conditions pertaining to waste disposal as set forth in Conservation Dept. P. A. 47-12.

Date	Subject	Remarks
7-6-56	Amendment to P.A.47-12 granted by Commissioner of Conservation	The amendment increased the amount of appropiration of water from Lake Superior for beneficiation and steam power for plant capacity of 10 million tons of concentrate per year from 130,000 gpm to 260,000 gpm. The amount of appropriation for domestic in-plant use was increased to an amount required for 2,000 persons.
9-25-56	Hearing by Water Pollution Control Commission to amend permit of 12/22/47	Duluth, Minnesota
11-25-56	Amendment of permit of 12/22/47 to discharge industrial water issued by Water Pollution Control Commission	To allow increase in discharge of waste water & tailings from plant operation.
7-13-60	Hearing by Water Pollution Control Commission to further amend permit of 12-18-47 and the amendment of 11-12-56	Duluth, Minnesota
9-1-60	Second amendment to P.A. 47-12 granted by Commissioner of Conservation	The amendment increased the amount of appropriation of water from Lake Superior for the beneficiation plant and steam power plant from 260,000 gpm to 502,000 gpm.
9-8-60	Second amendment of permit of 12-22-47 as amended 11-12-56 issued by Water Pollution Control Commission	To allow increase in discharge of waste water & tailings from the plant operation.

APPENDIX II

LIST OF STUDIES, INVESTIGATIONS AND REPORTS INVOLVING THE RESERVE MINING COMPANY, TACONITE PLANT AT SILVER BAY, MINNESOTA.

I. Studies and reports prior to issuance of P.A. 47-12 on December 18, 1947.

1. Report, "Physical and Chemical Properties of Taconite Tailings and The Effect of Their Disposition on the Fishes of Lake Superior", John B. Moyle, Division of Game and Fish.
2. Study and Investigations - Sizing and Chemical Analysis Taconite Tailings - University of Minnesota, Mines Experiment Station (testimony at public hearing in 1947.)
3. Study and Investigations - Laboratory tests of taconite tailings - size characteristics, rates of settling, clarification of tailings, simulated tests of effects of tailings deposition using model studies. Also tests of water tempreatures, turbulance currents in Lake Superior and tests of sediment discharge from streams. Adolph Meyer, private consultant (testimony at public hearing in 1947.)
4. Study and Investigations - Characteristics of Tailings - Reserve Mining Company (testimony at public hearing in 1947)
5. Study and Investigations - Mechanical Composition of Tailings and Hydraulic Tests- model studies of simulated effects of tailings deposition in the lake. Lorenz Straub, University of Minnesota, St. Anthony Falls Hydraulic Laboratory (testimony at public hearing in 1947.)
6. Study and Investigations - Tests of Tailings - Wisconsin Water Pollution Control Committee

II. Studies and reports after issuance of P.A. 47-12 on Dec. 18, 1947

7. Report - Report on Investigations of Lake Superior near Beaver Bay, Beaver Bay, Minnesota. July and September, 1948.

The investigation was made to determine the present characteristics of the lake water and the bottom conditions in vicinity of Beaver Bay, and what methods may be feasible for identifying and measuring the effect of pollution caused by the discharge of tailing into the lake. Minnesota Department of Health, Division of Water Pollution Control.

8. Report - Water Quality and Sediment Studies - Analytical Data on Baptism River and Beaver River mouths and bays, Minnesota Water Pollution Control Commission. (May 3-5, 1949)
9. Report - "Lake Superior Sediment" Tabular data in report is discussed. Use of grunerite as a valid indicator of taconite tailings is unreliable. New techniques are being explored to provide a valid, reliable indicator. (A Condensation from the monthly reports of W. D. Trethway, Reserve Mining Company, 1948-1949.)
10. Report - Investigational Report No. 99 - Fisheries Investigations conducted in connection with taconite beneficiation activities at Beaver Bay, Minnesota. Charles R. Burrows, Division of Game and Fish, January 30, 1950.
11. Report - Memorandum, Division of Game and Fish - including data collected on survey of Lake Superior and some tributary streams in the vicinity of Silver Bay, Lake County, Minnesota (1948-1954.)
12. Data on Investigations of Lake Superior and Some Tributary Streams in the Vicinity of Silver Bay, Lake County, Minnesota, July 26-30, 1954. Minnesota Department of Health.
13. Report - Including data collected on survey of Lake Superior at Beaver Bay, Lake County, Minnesota (1948-1954). Minnesota Department of Conservation, Division of Game and Fish, Fisheries Research Unit.

14. Report - "Conference of the Technical Committee on the Joint Investigation of Lake Superior prior to Taconite Beneficiation Activities at Silver Bay, Lake County, in Room 360, State Department of Health, University Campus, Minneapolis, Minnesota, March 8, 1955.

15. Report - "Data on Surveys of Lake Superior and Some Tributary Streams in the Vicinity of Silver Bay, Lake County, Minnesota. July 12, 13 and 23, 1955.

16. Report - On "Survey of Lake Superior in Vicinity of Silver Bay, August 21-23, 1956." First survey of conditions since the plant at Silver Bay went into operation in July, 1956. (Dated September 24, 1956) Division of Game and Fish.

17. Report - "Observations and Examination of Samples of Materials Accumulated on Fishermen's Nets in Silver Bay Area of Lake Superior, October 9 and 10, 1956." Dated October 22, 1956. Jones and Moyle. Division of Game and Fish.

18. Summary of Report "Preliminary Limnological Study" School of Public Health, University of Minnesota. January 1957. Based on a Lake Superior Study conducted during the summer of 1956. Ruschmeyer, Olson, Bosch, Redfield, Odlong.

19. "Lake Superior Study, Summer of 1956" by Ruschmeyer, Olson, Bosch, Redfield, Odlong. Published June, 1957. School of Public Health, University of Minnesota.

20. "Investigation of Disposal of Tailings, E. W. Davis Works. Reserve Mining Company, Silver Bay, Minnesota. August 5-9, 1957. Minnesota Department of Health.

21. "Supplemental Investigations of Complaints Pertaining to Effects of Discharge of Taconite Tailings from the E. W.

Davis Works into Lake Superior at Silver Bay, 1956 and 1957" (No report date.) Minnesota Department of Health. (Johannes and Thomas.)

22. "Bottom Samples in and Near Silver Bay, Lake Superior" G. M. Schwartz, Minnesota Geological Survey, University of Minnesota. January 9, 1958.

23. "Investigation of Waste Disposal, E. W. Davis Works, Reserve Mining Company, Silver Bay, Minnesota. August 25-29, 1958. Kiester and Rogers. Minnesota Department of Health.

24. "Lake Superior Limnological Data, 1951-1957" Reported by: Beeton, Johnson, Smith. Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Special Scientific Report Fisheries No. 297. April, 1959.

25. "Reserve Mining Fly Ash Sample" Minnesota Water Pollution Control Commission. Dated September 10, 1959.

26. "Report of Tests for Taconite Residuals in Lake Superior, 1957 and 1958". Ritchie and Johannes and Rogers, Minnesota Water Pollution Control Commission. (About November 1959-No date.)

27. "An Investigation of Nutrients in Western Lake Superior." School of Public Health, University of Minnesota for Minnesota Water Pollution Control Commission. (June, 1960.)

28. "Studies on the Productivity and Plankton of Lake Superior." June 1961. School of Public Health, University of Minnesota, Department of Health for Minnesota Water Pollution Control Commission. By: Hugh D. Putnam and Theodore A. Olson with other contributors.

29. Two tables showing records of annual catches of herring from 1949 to 1966 from Lake Superior, North Shore, Minnesota. By: Minnesota Department of Conservation, Division of Game and Fish, Section of Research and Planning. Dated October 20, 1965.

30. Investigation Report - Semi-Annual Lake Water Condition Reports - Silver Bay Operations - Reserve Mining Company. Dated May 1958 to January, 1967.

31. Investigation Report - "Water Resources Data for Minnesota. Part 1. Surface Water Records. Part 2. Water Quality Records." Dated 1966 (and 1967) By: U. S. Department of the Interior, USGS.

32. "Report on an Investigation of the Pollution in the Lake Superior Drainage Basin Made During 1965 and Minnesota Water Pollution Control Commission.

33. "History of E. W. Davis Works, Reserve Mining Company, Silver Bay." Minnesota Pollution Control Agency. (As of October, 1967.)

34. Memo Report. "Reserve Mining Company, Taconite Pelletizing Waste, Silver Bay, Minnesota." Dated January, 1968. This report tells of two sampling periods and observations. The first period was on May 12, 1967 followed by ground reconnaissance on May 24. The second period was from September 14 to 22, 1967. U. S. Department of the Interior, Federal Water Pollution Control Administration, Great Lakes Region, Chicago Program Office.

35. File from U. S. Department of the Interior, Geological Survey, Charles R. Collier, District Chief. To, Mr. Clifford Risley,

FWPCA, Chicago Program Office. This file pertains to water quality in Lake Superior and its drainage basin. There are six items including three bound reports issued by the State of Minnesota, Department of Conservation, Dated June 1963, November 1964, and February 1966. Also, three sets of data sheets on samples collected and analyzed, are assumed to be from the U.S.G.S. The spring and summer sampling program for 1968 will include the Baptism River near Beaver Bay, Minn., and the Beaver Bay River at Beaver Bay, Minnesota.

36. Investigation of the Distribution of Taconite Tailings in Lake Superior, U. S. Department of the Interior, Federal Water Pollution Control Administration, Great Lakes Region, September-October, 1968.

37. Effects of Dumping Taconite Tailings in Lake Superior on Commercial Fisheries, U. S. Department of the Interior, Bureau of Commercial Fisheries, August 14, 1968.

38. Report of Tailings Disposal at Reserve Mining Company's Plant, Silver Bay, Minnesota, U. S. Department of the Interior, Bureau of Mines, Twin Cities Office of Mineral Resources. 1968.

39. Bioassays of Taconite Wastes Against Fish and Other Aquatic Organisms, U. S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, October, 1968.

40. Preliminary Report on Streamflow Conditions and Sedimentation in the Vicinity of Silver Bay, Minnesota, U. S. Department of the Interior, Geological Survey, November 1968.

41. Bottom Fauna of the Minnesota North Shore of Lake Superior as Related to Deposition of Taconite Tailings and Fish Production, State of Minnesota, Dept. of Conservation, Division of Game and Fish and the Minnesota Pollution Control Agency, October 10, 1968.

Robert Rygg

Because of the great interest in biological aspects of these studies, I will briefly review the nature of the bottom sampling program and past and present fish population analyses.

Samples of the bottom, including bottom dwelling animals, some of which are fish food, were taken in the summer of 1949 before the Reserve Mining taconite processing plant began operation and again in the summer of 1968 after the plant had been in operation for 12 years, since 1956. The work was done by personnel of the Minnesota Department of Conservation and the Minnesota Pollution Control Agency.

The 1968 study of bottom sediments and organisms was proposed in November 1967 to the Minnesota Pollution Control Agency by the Minnesota Department of Conservation and joint plans made for this work. Later (early in 1968) a similar study was proposed as part of a wider investigation by a task force of several Federal agencies coordinated by the U. S. Department of Interior. To eliminate duplication of work it was agreed by the State agencies that they would investigate the bottom fauna and its relationship to tailings deposits and that the State report would be made available to Federal agencies.

The area sampled in 1968 extended from 5 miles above (northeast of) the plant to 15.5 miles below (southwest of) the plant. Samples were taken at depths of 100 to 400 feet (extending to about 1 mile off shore) this being the principal area used by fish. Reserve Mining furnished a boat and crew for the study and the field work was observed by personnel of the Federal Water Pollution Control Agency and the Wisconsin Department of Natural Resources who were on board the boat during sampling. Laboratory work on the counting and identification of bottom organisms was done by the Minnesota Department of Conservation and Minnesota Pollution Control Agency. Reserve Mining Company analyzed bottom materials to determine the presence of taconite tailings.

Fewer fish food organisms (scuds or small fresh water shrimp of the genus Pontoporeia) were found on the bottom covered with tailings below the plant than above the plant. However, total production of bottom organisms was greater below than above the plant. Considering the kinds of fishes taken in the area and their feeding habits, it was calculated that the reduction of fish food organisms on the bottom could possibly result in a reduction of the total annual fish catch (commercial and estimated sport fishing) of 5 percent or less for the area having tailings on the bottom. This reduction would amount to 25 to 65 pounds of fish per square mile of water and probably be mostly of smelt. In the present study the area of bottom found covered with tailings at depths primarily inhabited by fish was a zone about 1 mile wide extending at least 15.5 miles downshore from the plant. This was as far downshore as bottom samples were taken.

It should be emphasized that the foregoing calculations on the possible effect of the fewer fish food organisms found are theoretical only. There is no evidence from data on the commercial and sport fishing catch along the North Shore of Lake Superior to show there has been an actual reduction in fish production. Further study of both bottom fauna and fish in the area of tailings deposition would be necessary to determine this.

Twenty years of commerical catch records show that great changes have taken place in the fish populations of Lake Superior. Most changes have been lakewide and began before the plant went into operation.

The lake trout population is now recovering from a decline that began in the mid-1940's. This decline was caused by the imposition of the sea lamprey onto a population already intensively harvested by commerical and sporting means. Spawning stocks were decimated in all inshore waters during the 1950's, the collapse of the fishery became inevitable in 1960-1961.

Only drastic reduction in sea lamprey populations in 1962, followed by intensive stocking efforts, prevented total collapse of the lake trout fishery. Recovery of the lake trout is in progress, although natural reproduction is almost entirely lacking in Michigan, Ontario, and Minnesota waters. The only spawning of consequence occurs in the Apostle Islands region 20 to 30 miles from the Reserve Mining plant.

The decline of lake trout began in Minnesota, as in the rest of the lake, years before the Reserve Mining plant went into operation, and no relationship between the two events can be demonstrated.

Robert Rygg

Changes have also taken place in the herring population. Production of this fish has declined more or less steadily in all U. S. waters of the lake since the early 1940's and this condition continues to date. The same catch trends have been noted above and below the taconite plant.

Other commercial species, such as smelt and chubs, have increased during the period of plant operation. Minnesota and Wisconsin have become the largest producers of smelt. Here again the timing of these changes cannot be related to the taconite plant, as the changes in trends started in the early 1950's.

At the outset I stated our great interest in Lake Superior. I will repeat with emphasis that the Minnesota Conservation Department, the people of Minnesota, and people of the United States will not allow the deterioration of this great body of fresh water.

Our studies of the record and of the lake indicate that present taconite operations are not currently having an appreciable effect on fish production in the lake.

However, the effects of future activities of this plant should be carefully monitored and any present or future addition of any wastes be considered in terms of possible total aggregate effects.

Therefore, we urge a united effort to: (1) gather more detailed information on the present condition of the lake; (2) embark on a unified cooperative program to stop waste disposal that adversely affects water quality wherever it occurs.

I want to emphasize this last point because I firmly believe that only through unified cooperative efforts can we resolve problems of this kind. Working together we can keep Lake Superior as the finest, largest body of clear, fresh water in the world.

Thank you very much, Mr. Chairman.

(Applause.)

MR. DOMINICK: Thank you very much.

I think as Minnesota proceeds here we should, perhaps, make the individual witnesses available for questioning at the close of their statements.

Do we have any qeustions from the conferees?

MR. STEIN: I have one for Mr. Rygg.

Would you come up for a question, please.

You talked about your sampling program for vital organisms and sediments in 1968 extending 5 miles above (northeast of) the plant and 15.5 miles (southwest of it) extending to about a mile offshore. As I look at the map I tried to do it when you made your statement - these are all Minnesota waters you were talking about?

MR. RYGG: Yes, sir.

MR. STEIN: Thank you.

MR. DOMINICK: Are there any further questions?

(No response.)

MR. DOMINICK: Thank you very much.

MR. BADALICH: Mr. Chairman, if we may resume the Minnesota presentation, at this time, Mr. Chairman, I would like to call upon Mr. Ed Pride, the Counsel for Reserve Mining Company, who will introduce a list of speakers on behalf of Reserve.

E. Fride

I think Reserve has been mentioned many, many times during this conference in past reports, etc., I suggest to Mr. Fride that we reserve the initial presentation in a general-nature-sort-of and overview of their operation which will be limited to approximately two hours this morning. Following the balance of our presentation and Wisconsin and Michigan, they also will be given ample time to present to the conference their experts, biologits, ecologists, geologists, etc., to finish off their particular presentation.

I have received from Mr. Fride copies of the statement Mr. Edward Furness, President of Reserve; Mr. Edward Schmid, Assistant to the President, Reserve Mining Company; Mr. Kenneth Haley, Vice-president and Manager, Research and Development, Reserve Mining; Mr. Earl Ruble, Consulting Sanitary Engineer, Duluth; Dr. Robert Bright, Associate Professor of Geology and Ecology at the Limnological Research Center, University of Minnesota, Minneapolis; Dr. G. Fred Lee, Director of Water Chemistry Program for the University of Wisconsin; Dr. Robert Ragotzkie, Professor of Meteorology and Director, Marine Studies Center, University of Wisconsin; James Rice, Consulting Chemical Engineer from Pittsburgh, Pennsylvania; and these I will be distributing to the Conferees.

Reserve has asked me to make these statements as part of the record and I concur in their request.

With this, Mr. Chairman, I would like to call on Mr. Fride, who will make the presentation on behalf of Reserve.

MR. DOMINICK: Very well.

MR. FRIDE: Thank you very much, Mr. Badalich.

Chairman, conferees, ladies and gentlemen:

At this time Reserve, as I understand from the Commissioner's position, will prepare to make a brief overview of its operations and will then recess pending the presentations by the State agencies and will then be afforded an opportunity to resume and present testimony by the scientists who have just been listed by Mr. Badalich. I can assure the conferees we will make every effort to be brief, and the experts have been asked to summarize their conclusions. But I do believe it is very important to the conferees and to the people here gathered to have an opportunity to get a full scope of opinions and data from these experts. I think it is consistent, of course, with the fact-finding concept of the conference. I would say the presentation is, of course, without any prejudice to the position of the company with respect to scope or possible action that the conferees may take here. But we do welcome very much the opportunity to present the evidence at this gathering not just recently but has been gathered long since before this plant commenced operation and ever since.

At this time, consistent with the outline of the program that Mr. Badalich made, I will call on Mr. Edward Furness, the President of Reserve Mining Company.

(Applause.)

STATEMENT OF EDWARD M. FURNESS,
PRESIDENT, RESERVE MINING COMPANY,
SILVER BAY, MINNESOTA

MR. FURNESS: Mr. Chairman, conferees, ladies and gentlemen:

My name is Edward M. Furness. I am a resident of Silver Bay, Minnesota, and I am President of Reserve Mining Company. I am a graduate engineer, with a Bachelor of Science degree in civil engineering.

I think I will digress a moment from what I am going to say later to refer to a model that we have here showing the 20 percent of the western half of this great lake of ours. I would like you to particularly note the contours of the lake just off the shore from Reserve Mining Company. You will hear us talking about this deep trough, which is 600 to 900 feet deep, where our fine tailings ultimately come to rest. During this presentation we will also try to demonstrate by mathematical calculations that the entire ore body or the waste part of our ore body, i.e., the fine tailings from Reserve, could all go in this trough and it would only be raised a matter of a few feet in the depth of water 600 to 900 feet deep.

Reserve was the first large-scale taconite operation in the world. It was the leader in taconite development in Minnesota, a development which has meant so much to the State and to the people of the Mesabi Iron Range. It also has an important impact on the Nation s industrial economy. We are the principal iron supply for companies which produce about 15 percent of the Nation's steel.

From a conservation standpoint Reserve's use of Lake Superior is sound. These is no waste of water, no injury to water, and it incorporates harmless, permanent deepwater deposition of inert tailings.

We know of no evidence that we are in violation of any permits, and we are in compliance with water quality standards of the State of Minnesota recently approved by the United States Department of Interior.

Tailings are simply fine and coarse sand, physically similar to the material which has been entering the lake from the rivers and streams along the Minnesota and Wisconsin and Michigan shores for centuries and similar to the material that is washed from sand beaches or worn away by waves breaking constantly against the cliffs and which erode rocks and stones along the North Shore, except that much of these natural sediments are finer than Reserve's tailings. No oils, no chemicals, no toxic materials are used in the processing of taconite by Reserve.

It should not be necessary to stress the importance of the development of taconite processing. Because of the rapid depletion and approaching exhaustion of the direct shipping ores and easily-concentrated natural iron ores on the Mesabi, Vermillion, and Cuyuna Ranges of northeastern Minnesota, that area, once rich and productive, was facing economic collapse. The development of methods of mining and producing a usable product from the hard rock low-grade iron formation known as taconite offered the only method of saving the economy of the region.

The importance of taconite to the economy of this region is familiar to all Minnesotans, but the significance to the rest of the Nation is perhaps less well known. The rapid depletion of direct shipping ores during World War II brought about an intensive search for new supplies and this search was by no means confined to the United States. In no time at all large deposits of high quality, readily accessible ore were located in half a dozen countries, especially in South America and in Africa, and important new ore fields were explored in eastern Canada. The Lake Superior region appeared to offer nothing which could compete with these other deposits, but then the taconite concentration process had not been fully developed. When it was, and when a sufficient quantity of pellets had been produced to permit a true production scale test, the proven worth of this material, together with the natural desire to maintain a source of this essential material within the continental limits of the United States, brought a new surge to the economy of the Lake Superior region.

Reserve was organized in 1939 for the purpose of exploring the possibility of going into the taconite business in Minnesota. There had been an earlier attempt in 1921 to produce a high-grade concentrate from Mesabi taconite at Babbitt, but the operation was a failure and that company closed down in 1923 without having made any substantial shipments.

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Many of the technical problems were solved by the untiring work of the staff at the University of Minnesota Mines Experiment Station, under the direction of Professor E. W. Davis. Reserve cooperated in much of this experimental work, and by 1947 we believed that taconite processing was economically feasible.

Mining and processing taconite is a difficult and expensive process. Babbitt taconite is one of the hardest rocks found on the surface of this continent. Reserve's taconite deposit contains only 20 to 25 percent iron in the form of magnetite (black magnetic oxide of iron). Unlike the rich red hematite ores of the Mesabi, the hard,gray taconite, with its streaks of black magnetite, requires extensive processing and beneficiation. The particles of magnetite are locked into the rock in finely disseminated particles. Because of this characteristic, it must be ground fine in order to free these particles from the waste sand.

A substantial part of the success of Reserve's taconite operations is the availability of large quantities of water. The grinding and the following magnetic separation stages, where the magnetic iron ore is recovered from the waste sand, is done with the material suspended in water. It requires 50 tons of water to make 1 ton of finished iron ore concentrate, about 12,000 gallons. We use about 350,000 gallons of water a minute.

On the subject of water use in taconite processing, let me point out one thing - water is used but it is not lost. The separation process uses no heat; therefore, there is no evaporation except what would occur naturally. Thus, after the water is used and the tailings settle out, the water again becomes part of the existing water supply.

Reserve's earliest studies showed that it wasn't possible to conduct its concentration process at Babbitt, the site of our mine. Babbitt is on the eastern end of the Mesabi Range. Actually the Continental Divide runs right through Reserve's mineral body. There simply was no water available in Babbitt in the quantities required by a large-scale operation such as ours. Also, because of its location near the Superior National Forest and near the boundary waters, there was no area available to Reserve for tailings disposal. The only solution, engineering studies made clear, was to locate the processing plant at Silver Bay and bring the crude taconite there by rail from Babbitt.

It is very expensive to haul that crude rock down to Silver Bay. We had to build a 47 mile, double -tracked railroad through muskeg and rock, the worst kind of terrain. And, since we mine 3 tons of taconite for every ton of pellets we make, two-thirds of all the material we haul is unusable.

Of course we would have located the processing plants near the mine if that had been possible. Other taconite companies do it becuase there is available sufficient water for processing and large tailings disposal areas. But Reserve had no choice. Reserve is at the source of the rivers flowing down to Lake Superior, not far enough down them - as are the other taconite companies - to rely on them for a water supply.

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After thorough study, then engineers agreed that the only possible site for our processing plant was on the North Shore of Lake Superior at what is now Silver Bay. The site was suitable both becuase of the existence of nearby islands to which breakwaters could be built forming a harbor, and directly off shore from the plant is a very deep area of Lake Superior.

This deep area, a great depression extending for many miles parallel to the shore, is 600 to 900 feet deep. Its proportions are immense: up to 8 miles wide, 59 miles long - big enough to hold our entire Babbitt orebody without raising the bottom more than a few feet. It is here that our tailings settle.

Before I describe the process by which we beneficiate taconite, I might point out that the tailings are pure sand left over after the particles of iron ore have been removed. They are inert, inorganic, insoluble in Lake Superior, and biologically inactive. As you will hear later in our presentation, there is no material discoloration of the water and the turbidity has not been adversely affected by Reserve's operations. We have not seen any evidence that our use of Lake Superior has in any way harmed the lake as a source of pure drinking water, nor is there any real evidence of any ill effect on fish or aquatic life.

Before the Department of Conservation of Minnesota and the Water Pollution Control Commission would make any decision on the permits, they insisted on hearing from the other State and Federal agencies interested. The aquatic biologist of the Fish and Wildlife Service of the Federal Department of the Interior in charge of

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Great Lakes Fisheries problems reported:

> "It is our conclusion that this project will have no important effect on fish and wildlife resources, and this service has no objection to the construction of the project."

These conclusions that there would be no adverse effect on fish life have been borne out by the reports of the Federal and State agencies charged with the study and protection of fish life, as submitted in the recent 1968 "Group Study." For example, one of these reports by heads of three Federal agencies dealing with Great Lakes Fisheries, entitled "Effects of Taconite Wastes on Aquatic Life," says:

> "Great changes have occurred in the fish population of Lake Superior, but no evidence was found in a review of the commercial fishing statistics that taconite waste is influencing the populations." (Page 5.)

The Bureau of Commercial Fisheries of the Department of the Interior in its part of the studies divided the North Shore of Lake Superior into three areas in order to examine the changes in commercial fishing. The Silver Bay area where Reserve's effluent is discharged was in Area No. 2, the middle portion of the North Shore. The Bureau reported:

> "Fishing success has declined, but the decline began in 1953 before the taconite operations began, and the decline has continued throughout the Area No. 2, even though most of the area is northeast of the plant. ***The decline in abundance of herring in Minnesota waters, whether considered

in total or by rate of decline, has been greater in Areas No. 1 and No. 3 than in Area No. 2. Those fishermen whose operations were in the immediate 'green water' in Area No. 2 had no worse nor any better fishing than in the rest of the lake." (Page 3.)

Besides herring, the Bureau of Commercial Fisheries comments on changes in other fish life. It says with respect to lake trout:

"We can say only that the decline of lake trout in Minnesota, as in the rest of the lake, began years before Reserve Mining Company's plant went into operation and that no evidence is available to indicate that there is any relation between the present status of the lake trout population and taconite operations." (Page 1.)

Of smelt, their report says:

"The increase of smelt was nearly coincident with the decline of lake trout and may have been related to it. The timing of the changes in the smelt population shows no relation to the Reserve Mining Company taconite operation." (Page 2.)

Of chubs, the report says:

"The changes in the chub (ciscos) fishery appear to be related mainly to economic factors and show no relation to taconite operations." (Page 2.)

Then, summarizing their data and tests, this Federal Bureau reported:

"In brief, to the author's knowledge, no evidence is available to indicate that any fish population in Lake Superior has been adversely affected by the Reserve Mining Company taconite plant." (Page 4.)

As part of this 1968 group study, the Minnesota Department of Conservation and the Minnesota Pollution Control Agency studied the possible effects on bottom fauna along the Minnesota North Shore area and found no effects from the deposit of tailings except for a decline in the production of scuds, a decline which "may be associated with tailings." Scuds are eaten mostly by smelt. After pointing out that this effect is insignificant, and after comparing the results of the commercial smelt catches, they make a final statement, which is from Page 9 of their report:

> "There is no evidence that there has been a decline in the Minnesota catch of smelt because of operation of the taconite plant."

They further state on Page 10 that there is no evidence that the discharge of tailings at Silver Bay has had an adverse effect on Lake Superior.

You have heard reports that tailings may be present in the water supplies of Duluth, Two Harbors, and Beaver Bay. Keep in mind that those reports said the tailings were identified by the presence of a mineral called cummingtonite.

Now, cummingtonite is commonly found in this highly mineralized region. Reserve scientists and technologists have found cummingtonite not only in Lake Superior itself but in streams which enter Lake Superior on the North Shore. Certainly, you would expect to find it in the Duluth water supply because the St. Louis River, which enters the lake at Duluth, drains the Mesabi Iron Range where cummingtonite abounds.

Cummingtonite by itself, therefore, is not a valid indicator of tailings. Our own scientists would never consider the presence of cummingtonite alone as a positive tailings indicator. We also would analyze the sample for other identifiers such as low titanium, low copper, low zinc, low cadmium, and etc. There is no reason to assume that simply because there is cummingtonite in a water sample that the source is tailings. From whatever source cummingtonite may be found in any water supply, it should be emphasized that it does not have any harmful effect on the water for human consumption.

I might say here that cummingtonite is a mineral in the same class with coarse sands which are used in most water plants to filter their water.

Taconite processing starts in our mine at Babbitt where jet piercers burn blast holes into the hard taconite. Explosive charges are set and "shot" and the blast-broken taconite is loaded into trucks which carry it to one of the two huge crushing plants near the mine. Here the pieces are crushed to minus 3½ inches and loaded into the rail cars for transportation to the processing plant at Silver Bay.

Processing calls for more crushing to reduce the taconite to miuus 3/4 inch and grinding in rod and ball mills until the material is fine enough to separate the magnetite from the waste sand. Grinding is done with the material suspended in water and, still in water, the finely-ground taconite goes through three stages of magnetic seperation and two stages of hydro seperation.

A final stage in the concentration process, vacuum filtering, removes about 90 percent of the water leaving a moist filter cake of black concentrate.

In our pelletizing department the concentrate is mixed with a small amount of bentonite and powdered coal and rolled into 3/8 inch pellets. The pellets are then fired at 2,300 degrees, converting them to hematite and making them strong enough to withstand the rough handling of shipment down the lakes to the blast furnaces for conversion to iron and steel.

The whole process, which I have described in overly simple terms, is very expensive and complicated. It involves hugh investments of capital and high labor and equipment costs. Our total capital investment is $350 million.

For Reserve it was even more expensive than for the other taconite companies which came later and located in established communities on the Iron Range. Before Reserve came to Minnesota, Babbitt was a ghost town - a monument to failure. Only one family lived in Babbitt when Reserve started: a caretaker who watched over the empty homes, school, and store buildings and the skeletal remains of a taconite operation which began with high hopes in the roaring twenties and ended in failure. Silver Bay did not even exist before

Reserve began building its new plant and harbor on the shore of Lake Superior. Scrub timber and rocky cliffs marked the region just north of the little village of Beaver Bay. The area population in both the Babbitt and Silver Bay region was less than one person per square mile in virtual wilderness.

It was necessary for Reserve to pay for the construction of streets and highways, schools, sewage and water treatment plants, recreational facilities and other features of a well-ordered, modern community. This was done in both Babbitt and Silver Bay. These communities have thrived and today over 95 percent of the homes are privately owned. The most modern schools were built and equipped at a cost to Reserve of about $11 million in the two communities.

Today Babbitt and Silver Bay have a combined population of about 9,000 persons - people entirely dependent on Reserve's operations for their existence. In addition, the fast-growing surrounding area - once nearly written off as a "Minnesota Appalachia - is thriving.

Last year, 1968, Reserve's State and local taxes paid totaled more than $3.7 million. Annual payroll for our 3,200 employees, including fringe benefits,was $29.4 million. Our purchases for goods and services were about $40 million in 1968.

Reserve officials knew that before construction could even begin at Silver Bay permits would have to be obtained from State and Federal authorities to allow the company to withdraw water from the lake and return it - with waste sand.

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In January 1947 Reserve applied to the U. S. Army Corps of Engineers for permits to construct the docks and harbor at Silver Bay and to deposit tailings into Lake Superior. The Army notified not only the other concerned Federal agencies and State and local governmental agencies, but also commercial fishermen, community clubs, sportsmen's clubs and conservation groups in the area as well as numerous residents along the North Shore of Lake Superior. Before granting any permits, the Corps insisted there first be approval of the operation by the Minnesota Department of Conservation and the Minnesota Water Pollution Control Commission, now the Minnesota Pollution Control Agency.

After publication and written notices to all interested groups in the State, the Minnesota agencies held extensive public hearings with the corresponding agencies of Wisconsin and Michigan participating. Eight hearings were held in April, June, July, September, and October of 1947, during which everyone was given full opportunity to be present and be heard. The matter of Reserve's use of Lake Superior was fully and thoroughly considered.

A leading hydrological engineer and former consultant of the Great Lakes Boundary Water Commission - Dr. Adolph Meyer - as well as the late Dr. Lorenz G. Straub of the University of Minnesota St. Anthony Falls Hydraulics Laboratory made extensive studies. They constructed models of the lake to show how tailings would act when deposited into the water under the most extreme conditions. They recommended that the tailings not be piped into the deep water, pointing out that where water containing material in suspension was piped into deep water there was a great deal of dispersion of mixing with adjacent water.

These and other experts concluded and recommended that the tailings be discharged directly into the lake across a beach where they would form a heavy density current. They explained that because the water containing tailings is heavier than the lake water, it would flow down to the bottom of the lake, always seeking the lowest level. The solids would settle into the Great Trough, the depression 600 to 900 feet deep to which I have already referred.

Mr. Edward Schmid, Assistant to the President of Reserve, will tell you more about the heavy density current later. It is enough for me to say that about 45 percent of our tailings are coarse enough to settle out immediately on our beach and never reach the lake. The other 55 percent flows over the beach in a thin layer of water which, by the time it reaches the edge, enters the lake gently, permitting the density current to form immediately. The density current, carrying the tailings, flows down the face of the delta and on into deep water where the fine particles settle out. I might mention that the water at the toe of the delta is over 400 feet deep and gets deeper gradually as the density current approaches the Great Trough.

There is nothing new or mysterious about heavy density currents. Scientists have studied about them for years. Perhaps you have seen them yourself in front of many of the North Shore streams flowing into the deep water areas of Lake Superior after a heavy rain. Such a stream laden with clays and silts, much of it finer than our tailings, is often a deep brown as it enters the lake, but the color stops abruptly rather than gradually fading out over a wide area of the lake. This is the density current at work carrying the fine particles to the bottom. If it didn't work this way, Lake Superior would not be the clear, pure body of water that it is.

To get back to the hearings, it was only after thorough study that the Minnesota Department of Conservation, the Water Pollution Control Commission, with the specific concurrence of the appropriate agencies of Wisconsin and Michigan, and the U. S. Army Corps of Engineers granted the three permits to Reserve in 1947 and 1948 to construct the facilities and deposit tailings into the lake at Silver Bay.

Subsequently, as the plant was expanded to its present capacity of about 10 million tons of pellets a year, the State permits were amended. In November 1950, July 1952, August 1960, and October 1960 amendments to the Federal permit were granted by the Corps of Engineers. The 1960 amendment specifically stated that the permit "has been amended by the Chief of Engineers to permit deposition of tailings into Lake Superior for an indefinite period." At a hearing before the Minnesota Pollution Control Agency in February 1968, Colonel Richard Hesse of the St. Paul District, Corps of Engineers, said the extension was granted for an indefinite period because it was anticipated that the present method of tailings disposal would continue for the entire life of the taconite processing plant.

Edward M. Furness

It was in full reliance upon those State and Federal permits that Reserve went ahead with its project for the production of iron ore from taconite and made the very large capital investments necessary.

Under these permits Reserve is required to make reports to the State authorities. Initially these reports contained the data and test results which were common in water permits of the late forties. As time went on and as scientific knowledge, equipment, and techniques advanced, the State called for further and expanded studies. Not only did Reserve comply, but actually, of its own volition, suggested numerous other tests, each time after consultation with leading consultant scientists and State authorities. Then Reserve would proceed to purchase the best available scientific devices and instrumentation to supply the new knowledge and data. Some of this equipment does not even exist anywhere else in the State.

As a result, our reports to the appropriate governmental agencies today cover a broad program of water sampling, analysis, investigation, and recording that has been expanded over the years so that it scarecely resembles our original program. Today it is almost a continuous year-round activity of our Reserach and Development Division. I am told that our water quality laboratory and our launch, which is fitted out with the latest scientific oceanographic equipment, are among the most modern and complete facilities of any industrial plant in the Nation. Reserve has, over the years, probably assembled more scientific data on Lake Superior than any organization - public or private.

Edward M. Furness

You will be hearing more about the scope of our water quality testing program later from Mr. Kenneth M. Haley, Reserve's Vice-President and Manager of Research and Development. This data includes studies of Lake Superior's biota, chemistry, mineralogy, currents, turbidity, temperature ranges, color, bottom characteristics and contours, as well as other considerations. The knowledge and skills of our own technical personnel have been augmented by consultants retained by Reserve - nationally renowned, recognized experts in their respective fields. Some of them will be making statements later in our presentation.

All of Reserve's acquired knowledge of Lake Superior is always readily available to reputable technical or scientific organizations interested in preserving the quality of this great body of fresh water. Because of Reserve's own interest in keeping Lake Superior clean and pure, we have always been anxious to cooperate in any way possible with any responsible governmental agency.

No agency, industry, or individual - public or private - is more interested in preserving the high quality of Lake Superior than is Reserve Mining Company. Our interest and concern for Lake Superior goes back many years - before we built our plant and before the question of water pollution caught the public's attention and received the serious consideration it deserves. In all our operations we have followed good conservation practices. We pledge to continue.

Thank you.

(Applause.)

MR. DOMINICK: Thank you.

I believe it would be appropriate if we had questions, if any, from the conferees at the completion of each of the statements.

Do we have any questions at this time?

(No response.)

MR. DOMINICK: We have no questions. Thank you very much, sir.

MR. FRIDE: Thank you, Mr. Furness.

The next speaker for Reserve Mining Company will discuss questions of density currents and will discuss the so-called green water phenomenon that some of the speakers have alluded to previously. He is Edward Schmid, Assistant to the President.

Mr. Schmid.

(Applause.)

STATEMENT OF EDWARD SCHMID,
ASSISTANT TO THE PRESIDENT,
RESERVE MINING COMPANY,
SILVER BAY, MINNESOTA

MR. SCHMID: Mr. Chairman, conferees, ladies and gentlemen:

My name is Edward Schmid. I live in Silver Bay, Minnesota, and I am employed by Reserve Mining Company as Assistant to the President.

I received a Bachelor of Science degree in engineering from the University of Nebraska in 1939. Before joining Reserve Mining Company in 1951 I was employed by Armco Steel Corporation in Middletown, Ohio.

Mr. Furness referred to the fact that Reserve's tailings - sand and gravel left over after the tiny particles of magnetite have been removed - are discharged into Lake Superior. He told you how, through the action of a heavy density current, the fine portion of our tailings discharge is carried down the slope of our delta into deep water. I will be discussing these density currents in more detail, as well as the so-called "green water" phenomenon.

As Mr. Furness told you, heavy density currents are not new and mysterious. They are as old as nature herself. The earliest detailed scientific studies of density currents we have encountered are reported by the United States Department of Agriculture and the United States Bureau of Reclamation in a booklet published in September 1942. Most of this report concerns a very detailed analysis of the action of the Colorado River, which carries enormous quantities of fine silt, clay, and other colloidally fine material, 250 million tons a year, into beautiful Lake Mead. Lake Mead, as most of you know, is formed by Boulder Dam impounding the waters of the Colorado River. This huge, deep lake is famous for its beauty, recreational facilities, and fishing, yet it is formed and fed by one of the dirtiest rivers (in terms of sediment load) on this continent.

The reason Lake Mead is clear, of course, is that the fine sediment has settled out. The reason Lake Mead remains crystal clear in spite of receiving 250 million tons of sediment (much of it colloidally fine silts and clays) from the Colorado River is that a heavy density current carries the fine materials to the bottom of the lakebed where they settle out.

Water with fine material suspended in it is denser - heavier - than clear water. As the Colorado River enters Lake Mead, it is heavier than the lake water which has no material in suspension. Therefore, it dives beneath the less dense, clear lake water and follows the contours of the lake bottom to the deepest part of the lake.

In exactly this same way our sand tailings are carried through a channel technically called a tailings launder and deposited on the beach in front of our plant at Silver Bay. The coarse material about 45 percent of the total is heavy enough to drop out promptly as the thin stream of water flows across the top of the beach. The beach, of course, has been growing through the years rapidly at first because the water was shallower near the shore. Now after 13 years of operation the growth of the delta is very slow because the beach has reached very deep water - 250 feet at the edge and more than 400 feet deep at the toe. As time goes on and the water get deeper, the rate of growth will slow more and more. The beach itself is solid, stable, and firm. You will frequently see big trucks and power shovels on it loading the coarse sand for use in road building, land fill, and other projects in the area.

The 55 percent of the tailings which are carried in the thin layer of water over the beach enter the lake. There, at the edge of the beach, the water heavily laden with sand dives beneath the clear water of Lake Superior, follows the steep incline down to the bottom, and flows like an underwater river seeking the lowest levels. That is our heavy density current. As it flows, particles settle out along the way, the largest, heaviest particles first, generally speaking. It flows down into the very deepest place in the area. This is the Great Trough to which Mr. Furness referred. There the heavy density current loses its velocity and the fine particles settle out. That is where they are supposed to go, according to our permits and according to all scientific predictions. Our extensive bottom sampling program proves that is where they are going.

As a matter of fact, natural sediments on the lake bottom are much finer than tailings at the very same spot. A typical size analysis shows that the percentage of natural sediments that is smaller than 5 microns, for instance, will be greater than the percentage of tailings that is smaller than 5 microns. And, of course, there has been no damage from these natural sediments, although they have been exposed to the water for centuries.

Some might be surprised that materials smaller than 5 microns approximately 0.0002 inch will settle at all. Obviously, they do or they would not be found on the bottom of the lake and Lake Superior would not be the clean, clear body of water that it is.

Our Mr. Kenneth Haley will submit technical data about the bottom of Lake Superior, but I might say, however, the deposits of natural sediments ultra fine clays, silts and the like have been found by scientists to be more than 600 feet thick on the bottom of Lake Superior natural sediments, not tailings. The thickest deposit containing tailings on the bottom in the Great Trough is only about 6 3/4 inches. Any mathematical calculation will show that Reserve's entire mineral deposit at Babbitt can be put into this Great Trough without raising the bottom of that 600 to 900 foot deep basin more than a few feet.

The heavy density current, then, takes care of the fine portions of our tailings just as it does with the natural sediments carried into Lake Mead by the Colorado River and the sediments dumped into Lake Superior every day by the many tributary rivers and streams in Wisconsin and Minnesota.

You will see this in a short piece of film prepared by technicians from the University of Minnesota Mines Experiment Station. One of them will pour into a glass-sized tank the very finest fraction of our tailings. You will see through the side of the tank that the heavy density current quickly forms and moves to the deepest part of the tank. Of course, the incline used in this tank demonstration is not as great as the incline of the face of our tailings beach. If it were, the heavy density current would, naturally, flow faster to the bottom.

After the profile look at this density current, you will see another brief view taken from above the tank. A rock has been placed on the bottom of the tank and you will see how readily the density current flows around the rock rather than jumping over it. That is because the density current always seeks the lowest level where it loses its velocity, comes to rest, and the particulate matter settles out.

Following this scene there will be a brief film strip showing a heavy density current in nature it is the Beaver River (located about four miles west of Silver Bay) carrying sand, silt, clay, decayed vegetation and organic materials into Lake Superior. You will notice the sharp dividing line between the blue of the lake and the brown of the river. This is the point at which the silt-laden Beaver River becomes a density current and flows down to the bottom of Lake Superior. It has been doing this for thousands of years and will continue to do so for thousands of years.

(Showed film clip.)

The following color footage was taken just a week ago, but it could have been taken yesterday, tomorrow, or 13 years ago since it is exactly what you see day after day at Silver Bay - the formation of the heavy density current that carries waste sand from our process down to the great depths of Lake Superior. You will see the plant, the tailings launder, our tailings beach and the water flowing across it into Lake Superior. And you will see how effectively the density current is working. Note that the water is clear right up to the point where the current dives to the bottom.

(Showed film.)

Edward Schmid

Now I would like to talk about - and show you photos of - what has come to be called "green water" which appears occasionally in Lake Superior. So-called "green water" has been studied by scientists for many years in Lake Superior and other bodies of water. It has been seen, studied, and photographed in lakes and oceans. Lake Superior is no exception. Scientists observed and studied what we refer to as "green water" in Lake Superior long before Reserve went into operation. Canadian scientists, in connection with their studies of thermal bars and thermoclines, have photographed and reported in technical papers on "green water" in Lakes Huron, Ontario, Superior, and other lakes.

Some people have erroneously concluded that "green water" is caused soleiy or mostly be tailings. However, if "green water" were caused by Reserve's discharge - and it is not - you would expect to see it near Silver Bay constantly. You don't. Residents of the North Shore know this. Also, the various Interior Department agencies which conducted the recent sutdy of Lake Superior reported that "green water" sometimes was apparent, sometime it was not. Specifically, the Federal Water Pollution Control Administration report which was presented this morning says, on Page 28: "Green water was observed along the Wisconsin shoreline and did not contain tailings." What causes these temporary, occasional areas of "green water" in Lake Superior has been a subject of study and investigation for years.

Edward Schmid

I am going to show you some slides of so-called "green water" as well as slides of water that actually is discolored. I will show you examples of water which has true color becuase of constituents in solution that give the water color - dissolved constituents ... like waters which originate in swamps and are frequently called "black waters" in Minnesota. The latter would have measurable color by a scientific instrument designed for the purpose.

Lake Superior waters normally are not colored. The lake looks blue when it reflects a blue sky, but a glass of Lake Superior water is clear, transparent, not blue, and has no measurable color ... a true color of zero. We all know that when the lake appears red at sunset - the water certainly is not red. The water which looks green in the lake is not green in a sampler A glassful appears clear and colorless to the naked eye and when subjected to prescribed color test procedures, it is colorless.

There is very little difference between the amount of suspended particles, or solids, in "green water" and so called "Clear" or "blue" water. For instance, the recent Federal study found, and I quote:

> "Water with suspended solids content of approximately one milligram per liter (1 mg/l) or more had a characteristic 'green' water appearance. Water at the edges or near limits of the 'green' water areas shows solids content near or slightly less than 1 mg/l."

Edward Schmid

Temperature differences can cause currents which may carry particles of inorganic matter, algae, or other aquatic life from shallows. These particles cause a change in light refraction, giving what appears to be a differnet color to the water from that of the colder, clear blue water farther out in the lake. This is why, on occasion, suspended particles can be naturally confined in areas along the shores by thermoclines. This is why "green water" occurs more frequently in early spring and late fall than at other times of the year. Tailings from our beach can also be carried by these temperature-created currents, occasionally, in the same manner as natural materials from other shoreline or shallow areas around reefs and islands.

Near Silver Bay you would expect to find tailings in "green water" under certain conditions, just as you would find natural sandy sediments suspended in "green water" near, for instance, a sand beach on the Wisconsin shore. However, it is only a very minute percentage of Reserve's tailings discharge that could be carried in this manner.

The first series of aerial color slides I will show you were made of the north and south shores of Lake Superior before Reserve began operating its Silver Bay plant - before any tailings were deposited on the beach or into the lake. They show the same heavy density currents at work and the same types of "green water" that we see on occasion today.

Edward Schmid

(Showed 1955 slides of Minnesota and Wisconsin shores)

Now I will show you 35 millimeter slides taken from an airplane approximately 60 seconds apart as the plane flew along the shore. We have been taking these 60-second photos periodically for nearly 5 years, whenever we notied "green" areas of other unusual conditions both near our operations at Silver Bay and elsewhere in the lake.

(Showed slides and narrated.)

A. "Green water" miles south of Silver Bay with Reserve's area clear.

B. "Green water" miles north of Silver Bay with Reserve's area clear.

C. "Green" and muddy water along Wisconsin shores, as is usually the case, with Reserve's area clear.

D. "Green water" in Lake Michigan.

We have many more sets of these slides taken by professional photographers of the north and south shores of Lake Superior. Also, we take color slides every day of the waters near our discharge, in the harbor area and south to East Beaver Bay. All of these are available for any technical, objective study.

We have learned a great deal from these slides. We learned that on the infrequent occasions when we saw "green water" it was, more often than not, located in areas far removed from our tailings discharge point. And close inspection revealed that the source of the "green water" was not our tailings.

Edward Schmid

We learned, for instance, that patches of "green water" were just that - patches here and there - not a continuous stream all along the shore. Because of this fact, it is easy to see how a motorist driving along the scenic North Shore may jump to the wrong conclusions. He gets an occasional look at the lake through the trees. If he sees patches of "green" or a patch of muddy water several times, he assumes there is one long, continuous stream of color flowing all along the shore. He might even assume - erroneously - that it originates at Silver Bay. He perhaps will not realize that these are probably entirely disconnected patches originating from different beaches and shallows or may be caused by temperature differentials. This is not to say that tailings are never present in "green water" in the area west of Silver Bay. I repeat, tailings can be present just as natural sediments are. But we have yet to find and we know of no one who has found tailings in "green water" in concentrations that violate the water standards for either color, turbidity or temperature.

While some people may say that "green water" is aesthetically objectionable, many do not. It should also be noted that there are great areas of "brown" water and different shades of "green" from natural sediments discharged during periods of heavy runoff and after storms which cause severe wave action along the shores and beaches. This "brown" is even more aesthetically objectionable. It is particularly noticeable in the case of Wisconsin's streams and shores at the western end of the lake.

Edward Schmid

The U. S. Geological Survey, Water Resources Division, recently reported, and I quote:

> "One of the most severely eroded and high sediment producing areas in Lake Superior is the red clay areas in northwestern Wisconsin."

The red clay sediments from these Wisconsin areas usually are responsible for the heavy turbid water which often appears in the Duluth-Superior vicinity of the lake and which has no connection with Reserve's discharge.

As far as "black water", swamp waters, and mud, silt, sand and clays are concerned, nature has been carrying tremendous tonnages into Lake Superior for thousands and thousands of years. I said "tremendous tonnages," but, in fact, they do not compare in volume to the incalculable volumes of fines that have been created by the wave action on beaches and shores. The beach pebbles are rounded because day and night they are constantly ground against each other. I am told that the original North Shore highway south of Silver Creek Cliff 35 miles north of Duluth is in the lake today. All into the waters of Lake Superior. These sediments have settled on the bottom of the lake - leaving Lake Superior among the very finest, purest, most beautiful bodies of fresh water in the world.

Thank you.

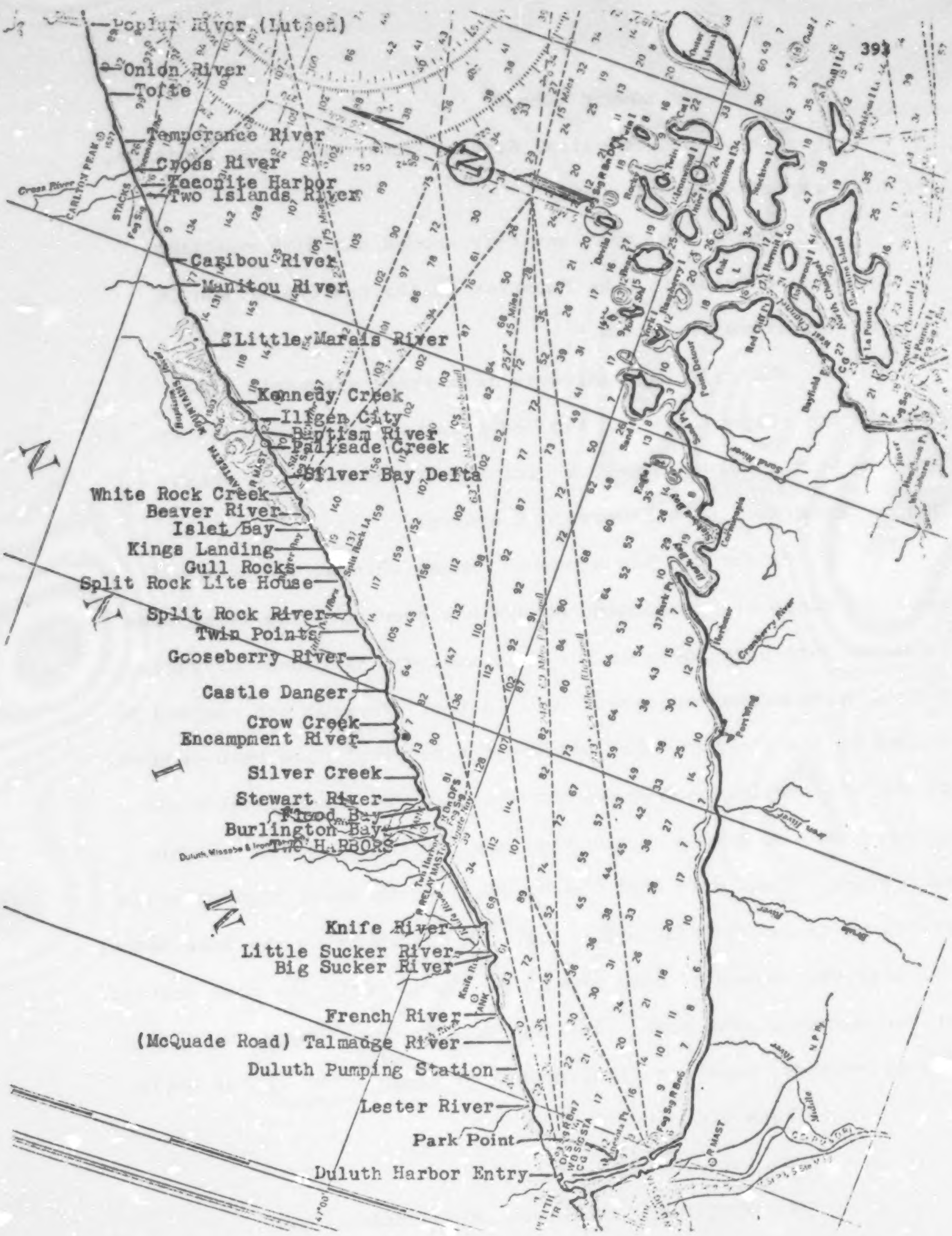
(Applause.)

MR. DOMINICK: Thank you, Mr. Schmid.

Do we have any questions?

(No response.)

MR. DOMINICK: Thank you.


Poplar River (Lutsen)
Onion River
Tofte
Temperance River
Cross River
Taconite Harbor
Two Islands River
Caribou River
Manitou River
Little Marais River
Kennedy Creek
Illgen City
Baptism River
Palisade Creek
Silver Bay Delta
White Rock Creek
Beaver River
Islet Bay
Kings Landing
Gull Rocks
Split Rock Lite House
Split Rock River
Twin Points
Gooseberry River
Castle Danger
Crow Creek
Encampment River
Silver Creek
Stewart River
Flood Bay
Burlington Bay
TWO HARBORS
Knife River
Little Sucker River
Big Sucker River
French River
(McQuade Road) Talmadge River
Duluth Pumping Station
Lester River
Park Point
Duluth Harbor Entry
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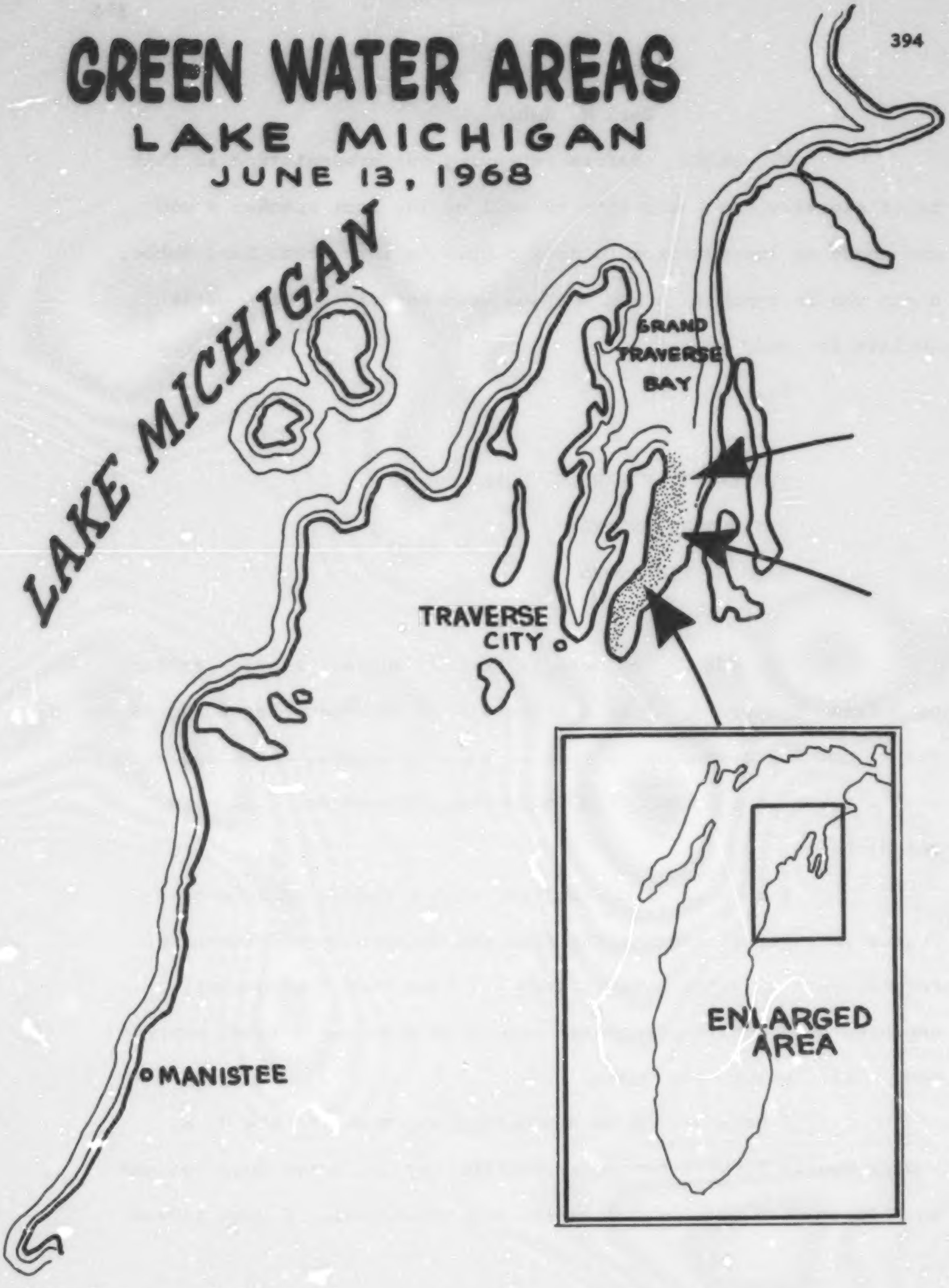
GREEN WATER AREAS
LAKE MICHIGAN
JUNE 13, 1968



Earl H. Ruble

MR. FRIDE: Before recessing our presentation in this brief overview, we would like to call as the last speaker a man who needs no introduction to most people in this area, Earl Ruble, a man who is capable, a man who has been associated with water quality for many years.

Mr. Ruble.

STATEMENT OF EARL H. RUBLE,
CONSULTING ENGINEER,
DULUTH, MINNESOTA

MR. RUBLE: My name is Earl H. Ruble. I am a resident of Duluth, Minnesota. I am a professional engineer practicing in Duluth and doing consulting work on water problems, including such work for numerous communities in northern Minnesota, Wisconsin, and Michigan.

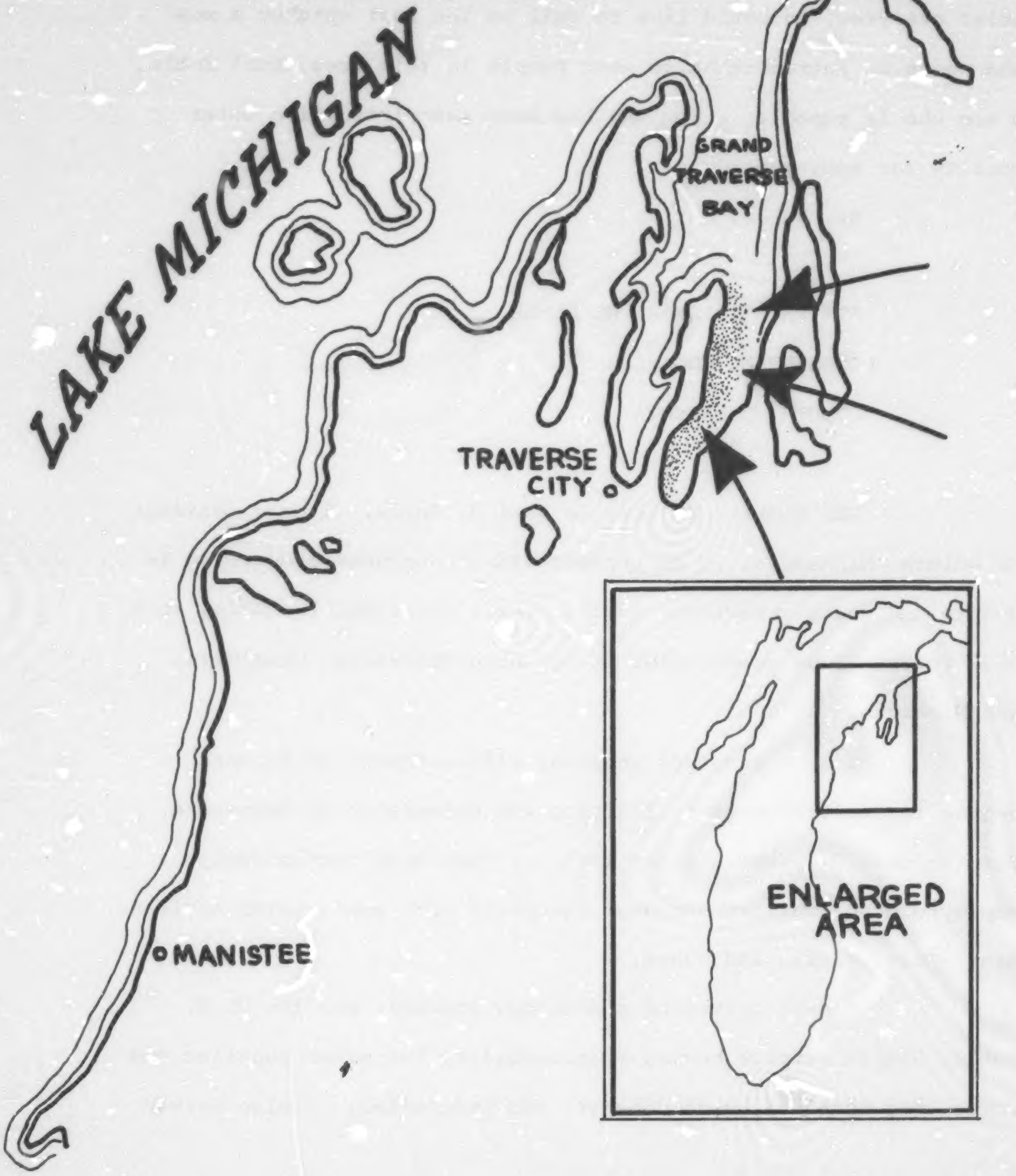
I am a chemical engineer with a Master of Science degree in sanitary engineering from the University of Minnesota. For the past 34 years - since 1935 - I have been continuously employed as a sanitary engineer concerned with man's total environment - air, water, and waste.

I have served as a sanitary engineer for the U. S. Public Health Service having responsibility for water supplies and wastewater disposal, both domestic and industrial. I also served

GREEN WATER AREAS

LAKE MICHIGAN

JUNE 13, 1968



as public health engineer for the city of Duluth from 1938 to 1955 and, during that time, was instrumental in establishing the Duluth Water Resources Laboratory. I have also served as sanitary engineer for the Minnesota State Board of Health.

As a consultant for the water treatment plants of Duluth, Two Harbors, Grand Marais, and Beaver Bay, as well as various municipal water plants of our neighboring States, I have become intimately familiar with the water supply systems and problems of the communities within this region. Also, over a period of many years, I have become familiar with Reserve Mining Company's operations and method of tailings disposal. During the original hearings on the matter of Reserve's permits I was a witness for the city of Duluth. In addition, I have served from time to time as a consultant to Reserve on matters of water quality.

Since 1955 I have been a member of the independent consulting firm presently known as Ruble and Kaple, Incorporated, Duluth. This firm employs approximately 50 persons with such diverse disciplines as chemical, mechanical, civil, electrical, and structural engineering; physicists, geophysicists, geologists, architects, hydrologists and biochemists, etc. Our large laboratory is fully staffed and equipped with the most modern water quality testing and analysis apparatus, including atomic absorption.

I was instrumental in setting up a 3-year study of the Duluth water supply to determine if traces of Reserve's tailings might be reaching the water intake. We determined, in preparing for this study, to look not for some rare indicator of tailings, but, instead, to search for the most common mineral in tailings - iron.

The study was run during the years 1955, 1956, and 1957. You will recall that Reserve's Silver Bay plant went into operation in 1955. For those 3 years the total iron in raw water at the Duluth intake was always less than 0.01 parts per million. I can say without reservation, from my own observations and studies, that Reserve's operations have had no detectable effect on the Duluth water supply.

I have examined various recent Federal Water Pollution Control Administration reports and note that there has been a failure to distinguish between trace metal concentrations which are soluble as distinguished from those which are insoluble. This failure, in my judgment, is not only unscientific but it can lead to erroneous implications and unwarranted fears.

There are data available reflecting that the natural sediments on the bottom of Lake Superior which have been there for many years contain greater concentrations of trace metals than do Reserve's tailings which are on top of the natural sediments. No harmful effect has resulted, nor is any anticipated.

Water quality is judged on five properties - temperature, appearance, taste, physical composition, and chemical composition.

The appearance of the surface of lakes, rivers, and oceans is usually described in terms of apparent color. A glassful of water dipped out of Lake Superior a short distance from the delta at Silver Bay appears to be clear and colorless and identical in appearance to tap water in Duluth, Grand Marais, or Two Harbors. When considered in these terms, Reserve's operations do not alter the appearance of the lake water.

I have studied and observed Lake Superior for more than 30 years. The surface of the lake presents a changeable appearance from time to time and from place to place.

The pronounced apparent red color occasionally seen at the western end of the lake and usually seen along the south shore is due to the clay sediments carried down the lake by the tributary streams and to the erosion along the beaches due to wave action. Of all the apparent changes in color, this red appearance is, by far, the most common.

The lake often appears to have patches or areas of other colors, such as purple, gray, green, and brown. When you view the lake from a high hill, for instance, these colors seem to change dramatically within a period of an hour or so - particularly when the sky is cloudy and the sunlight constantly changing.

A trained observer knows the color of the water is not changing. The light rays from the sun are being altered as they penetrate the atmosphere and reflect from the surface of the lake to the eyes of the viewer.

Some recent attention has focused on a so-called phenomenon known as "green water." Green-appearing water is seen in every large body of water, whether a lake or an ocean. In my 31 years of experience with Lake Superior, I have observed areas of the lake which appear to be green on numerous occasions before Reserve ever began operations. We have charted many of these apparent green areas - as well as other coloractions - over a span of many years.

It has been wrongfully assumed by some people that these "green water" areas are caused by Reserve's tailings. So far as suspended matter is concerned in relation to apparent color, I might say that whenever particles are present in water which may cause the appearance of color it is immaterial whether the substance is tailings or the product of beach or stream erosion.

It is possible, of course, that Reserve's tailings might be found in "green water," just as natural sediments also may be found in "green water." However, it is simply wrong to conclude that Reserve is responsible for the phenomenon. The fact is that if Reserve were to cease operations tomorrow we would still see "green water" just as we always have. I think the slides we have just seen bear that out well.

I have analyzed over a period of years sediments from the Wisconsin shore which various people suggested contained tailings. In every instance those suggestions were wrong.

As for turbidity, I personally have made hundreds of observations at the surface and at depths of 20 feet around the periphery of Reserve's permit area. The lake water consistently contains turbidity in concentrations of less than one Jackson Turbidity Unit (JTU). This is extremely low. The United States

Public Health Service turbidity standards for Class A domestic consumption water - the finest drinking water - specify a maximum turbidity of 5 JTU. Only close to shore where wave action produces a grinding action on the rocks and cliffs did we find turbidity of more than 1 JTU.

By definition turbidity is the measure of the amount of light penetration in water. Fine suspended particles reduce the clarity of the water and cut down the amount of light that will penetrate. Turbidity can be caused by microscopic living organisms and organic or inorganic materials, such as fine sand, silt, clay, sawdust fibers, and the like. These suspended particles can come from natural sources (erosion, rivers, streams, rain runoff and so forth) or they can be traced in some cases to industrial processes, such as dredging and logging.

The Duluth Water Department has reported on raw water turbidity readings since 1952 in its annual reports. During this span of years the turbidity has consistently been absent, less than 1 part per million most of the time. Such low values have been recorded for 87 to 99 percent of the time.

It is important to remember that the tiny particles in suspension, the particles that cause turbidity, do not stay in suspension indefinitely. If they did, the lakes of the world would have become seas of mud long ago.

If particles this small won't stay in suspension, it is obvious that Reserve's tailings don't stay in suspension in Lake Superior. The fact is that man could not possibly create permanent turbidity even if he tried.

Earl H. Ruble

So far as turbidity is concerned Reserve's operations have had no detectable effect in Duluth. Also, I have noted turbidity readings at Two Harbors during the past 14 years and have recorded no significant change in the lake water there.

From the foregoing observations which span many years, I believe Reserve's operations have had no significant or prolonged effect on Lake Superior so far as turbidity is concerned.

From my examination of the available data I have readily concluded that Reserve's tailings do not in any way violate the existing stringent Federal-State water quality standards. The "Appraisal" report suggests consideration of new proposed criteria. These proposed criteria are so unrealistic that if much of the population and industry were eliminated from this area, the water would still not meet these proposed criteria. The adoption of such would, in my judgment, be illogical and tragic.

To summarize, it is my opinion, based on more than 30 years' experience with Lake Superior, that Reserve Mining Company is not adding anything to our lake which will impair the quality of the water or present any hazard to human or marine life.

(Applause.)

MR. DOMINICK: Thank you.

Are there any questions?

MR. VOGT: Yes, Mr. Chairman, I have a question.

Mr. Ruble, you indicate that you carried on this study from 1955 through 1957 at the Duluth water supply intake and that your parameter that you studied was iron and the report was approximately 0.01 of a million. You also indicate on the next page that the natural sediments contain trace metals, and I presume some of these trace metals might be iron. Now, if you had found any, or you did find 0.01 of a part of a million of iron, how were you able to distinguish whether this came from the trace metals in the sediments or from Reserve's tailings?

MR. RUBLE: We started the study 6 or 7 months before Reserve went into operation so as to get a picture before the operation started. At that time our values were under 0.01, and this was about as far down as we could measure at that time. After Reserve started operations there was no change in the amount of iron regularly present in the lake water. Since there was no increase, we assumed that we were getting what you might call a background value that is present in the lake all the time.

MR. VOGT: In other words, that 0.01 that you initially found was apparently from the sediment on the bottom?

MR. RUBLE: Well, I don't know where it comes from. I don't think it would come from sediments, particularly. It probably is present in a dissolved form as a result of the contributions of the various streams that flow into the lake.

MR. VOGT: Thank you very much.

MR. DOMINICK: On that point, you indicate on Page 2 that the study was conducted during the years 1955 through 1956 and 1957. Has there been any continuation of that study?

MR. RUBLE: Not in the sense of it being a true continuation. The Water Research Laboratory pumping station, after three years of finding not the slightest change in the amount of iron naturally present in the water, we gave up the study on the grounds that when it arrived in the water supply it would have been in there at that time, so far as we could tell by testing for iron. The laboratory has made spot checks from time to time in the succeeding years and has found no change.

MR. DOMINICK: So essentially the statement which you made at the close of that paragraph on effects on the Duluth water supply is based upon the 1955 through 1957 study?

MR. RUBLE: Plus the fact that it has been checked from time to time in the succeeding years.

MR. DOMINICK: Thank you.

MR. VOGT: I have another question, Mr. Chairman. This is a matter of information for myself because I just don't know.

You decided that the best parameter to study at the Duluth water was iron because apparently there is iron or there is an assumption or a knowledge on your part that iron is actually present in the tailings, is that correct? I mean, is there iron contained in the tailings?

MR. RUBLE: Oh, there is, indeed. Of course all the taconite processing companies would like to get it out of the tailings as much as possible, but they can't get it all out. And the testimony that has been given during the time of the hearings revealed the fact that there would be iron in the tailings. Not knowing what else might be there, we started on the assumption that iron would be the most likely to be found if we found any evidence of tailings. We had to start this before tailings started to go into the lake. It seemed to us the most logical element to look for would be iron, and we still think that is a pretty good measure of the water quality.

MR. VOGT: I thought this process for this taconite would be so effective that they would be removing the iron?

MR. RUBLE: They are trying to make it that way.

MR. VOGT: I have another question. Is it your judgment that the iron in the taconite tailings is equal to or higher or less than the iron in the natural soils in that area which might flow into or might be washed by natural runoff or by the streams into the lake?

MR. RUBLE: I don't think I am entirely familiar with the iron content of the soils of the North Shore area. However, I should point out that the iron that comes out of taconite is insoluble, that is, a suspended form of iron rather than a dissolved form of iron. At the Lakewood Research Laboratory we analyzed it, the total suspension, so if the iron were dissolved we would find it and we didn't find it. I don't know how the iron content of the tailings would compare with other soils. I suppose the iron tailings might be more in other soils and some places it might be less. Here again we have to keep in mind that we are talking about iron that has no sigificance health-wise or aesthetically in the insoluble form. When it is in soluble form, it can cause some difficulty if it is present in too great a concentration.

MR. VOGT: Did you differentiate in your tests between the soluble and insoluble?

MR. RUBLE: No, we analyzed the total iron. It didn't make any difference whether it was insoluble or soluble in the tailings, we would have found it.

MR. DOMINICK: On the point that has been discussed most recently here, you chose iron as your mineral which you wished to study. Would you recognize any other traceable minerals which might be amenable to study?

MR. RUBLE: Not so far as I am concerned.

MR. DOMINICK: Do we have any other questions?

MR. FRANGOS: Yes, Mr. Chairman.

Mr. Ruble, you talk about the "green water" color here in your presentation. I just wanted to ask you one short question. On the basis of your experience and the studies that you have conducted, would you make the statement that the taconite tailings that are deposited by Reserve in no way contribute to the green coloration that we see in the lake?

MR. RUBLE: No. I would say that I am sure that tailings are associated with green color in the vicinity of Silver Bay, just as they would be associated with blue color, too, perhaps, but they are certainly not the cause of the color of the lake as a whole, but near the source of the tailings, I would expect that they would be a principal factor, perhaps.

I didn't quite answer Mr. Dominick's question fully.

I might also state that in addition to iron we might also look for titanium, because it is very low, but we didn't want to use a tracer that was hard to find; we wanted to use one that would be easy to find there.

MR. DOMINICK: I appreciate that clarification.

You did mention earlier that iron was but one of a number of tracers which might be used, and I think there might be some difference of opinion among experts on this point.

(Applause.)

MR. BADALICH: We will try to get back to Reserve Mining Company with the technical and scientific data they would like to present to the conferees before the matter closes.

At this point in the conference I would like to address a question to the conference. This is to more or less clarify the boundary of the Minnesota conference. The reason I bring this up is, as noticed in the conference report on Pages 58, 59, and 60, there are listed the municipal waste discharges and also the industrial waste discharges in the State of Minnesota, and in this list is shown the interstate sources as well as the intrastate sources. As you also note, in the fourth column of the table the abatement is listed there for the intrastate sources that have already been established by the Pollution Control Agency. At the time the conference was called I received a letter from the Secretary of the Interior Udall, and I would like to read part of this letter, stating the purpose of the conference and where it was going and the area that was going to be confined. It is addressed as follows:

> "In accordance with Section 10(d)(1) of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.), and on the basis of reports, surveys, or studies, I hereby call a conference in the matter of pollution of the interstate waters of Lake Superior and its tributary basin (Minnesota-Wisconsin-Michigan). The conference will convene on May 13, 1969, at 9:30 a.m., at the Duluth Hotel, 231 East Superior Street, Duluth, Minnesota. I have designated Mr. Murray Stein, U. S. Department of the Interior, as chairman of the conference.
>
> "The parties to the conference are the Minnesota Pollution Control Agency, the Michigan Water Resources Commission, the Wisconsin Department of Natural Resources, and the United States Department of the Interior. Participation in the conference will be open to representatives and invitees of these agencies and such interested individuals as make known to the Conference Chairman their desire to present statements.
>
> "A copy of the technical presentation to be made at the conference will be furnished you before the conference.
>
> "The conference will cover all interstate pollution problems of Lake Superior and its tributaries. As specified

in the Federal Water Pollution Control Act, we shall furnish a summary of the conference discussions to your Agency.

"Sincerely yours,

"Stewart L. Udall

"Secretary of the Interior."

On March 13, 1969, I wrote a letter to Mr. Walter Hickel, Secretary of the United States Department of the Interior. This was written following a conference we had with the Program Office in Minneapolis where we were given the opportunity to look into a preliminary draft of the conference report. At that time the tables I referred to earlier were listed in this preliminary report and, in turn, I wrote Secretary Hickel in an effort to clarify, and interstate sources were listed.

"Dear Secretary Hickel:

"This is in regard to the letter of January 16, 1969, under signature of Secretary Udall calling a Conference on the Matter of Pollution of the Interstate Waters of Lake Superior and its Tributary Waters (Minnesota-Wisconsin-Michigan).

"We have interpreted the former Secretary's conference limits to include only the interstate waters involved, which include Lake Superior, the St. Louis River and the Pigeon River in Minnesota. We are aware of no intrastate sources of waters within this basin in Minnesota which affect such interstate waters, or which we have reason to believe would be likely to cause pollution of these interstate waters. Accordingly, we will provide the Minneapolis Program Office with information on all sources within your jurisdiction.

"We would appreciate at your earliest convenience a letter confirming the above limitations of this conference so that we might concentrate our efforts and those of our staff and others on matters of significance concerning the waters of Lake Superior. As you are no doubt aware, the Lake Superior Basin in Minnesota exclusive of the St. Louis River Basin is relatively uninhabited and an in-depth analysis of this portion of the watershed would contribute very little to the purposes of the conference and divert our staff from essential tasks....

"We shall await your reply on these matters and again urge you to consider seriously limiting the scope of the conference to significant matters."

This is signed by myself as Executive Director.

On March 26, 1969, I received a reply to Secretary Hickel's letter from Assistant Secretary of the Interior Carl L. Klein, and it reads as follows:

"Secretary Hickel has asked me to reply to your letter of March 12, 1969, concerning the conference on the matter of pollution of the interstate waters of Lake Superior and its tributary waters (Minnesota-Wisconsin-Michigan).

"The conference is called under Section 10(d)(1) of the Federal Water Pollution Control Act and as required by the statute applies to the interstate waters and under Section 10(a) to pollution which endangers health or welfare in a State other than that which it originates. Such pollution falls within Federal jurisdiction in an enforcement action whether it originates in an interstate water or a tributary. It is my understanding from discussions with our Great Lakes Regional Office in Chicago that Lake Superior, the St. Louis River, and the Pigeon River are the only Minnesota waters which fall within the notice of conference and our statutory jurisdiction. I suggest at the conference that you may wish to make certain that this geographical limitation is made a clear matter of record.

"I have requested the Commissioner of the Federal Water Pollution Control Administration to direct Mr. H. W. Poston, Director of the Great Lakes Region, to discuss with you at an early date the possibility of changing the physical location of the conference and to make a recommendation to me.

"I have been directed by Secretary Hickel to chair the conference and I can assure you we will make every effort to see what conference discussions are focused on significant matters.

"I am looking forward to meeting with you in May and hope that the enforcement conference will be helpful to myself and the conferees in arriving at suitable methods of carrying out our respective statutory responsibilities.

"Sincerely yours, Carl L. Klein, Assistant Secretary of the Interior."

The reason I bring this up, Mr. Chairman, is that after referral of these letters and also referring to recommendations on Page 49, it is required in one of the recommendations of the conference we report all the sources listed on Appendix A, which is the appendix I made reference to. I feel the interstate sources as listed here on Pages 58, 59, and 60 relating to Minnesota and the municipal waste discharges and also the industrial waste discharges should be stricken from the conference report.

Following this, Mr. Chairman, I would like to go into the progress summary of each one of the interstate sources we have listed on this table and bring forth to the conference what action has been taken since the issuance of the abatement of municipalities so they will meet the abatement schedule as listed in the appendix.

Could I have clarification on the first matter, Mr. Chairman, regarding the sources as listed and whether they should be deleted?

MR. DOMINICK: Mr. Badalich, I am glad you brought up this question and we should seek clarficiation of it.

As you read Recommendation No. 9, it states, "Each State water pollution control agency make necessary corrections to the list in Appendix A of municipal and industrial waste discharges to the Lake Superior Basin." I am further led to believe that adjustments in thses lists can be made by the conferees upon a determination of effect with respect to the case that we have before us, the case being the interstate waters of the Lake Superior Basin. We would be happy to receive from you your recommendations for necessary corrections and make adjustments within the conference in accordance with the case that we have before us.

John P. Badalich

MR. BADALICH: Thank you, Mr. Chairman. That shall be done.

Mr. Chairman, if I may proceed with the progress summary of major interstate waste sources in the Lake Superior Basin, this will be in reference to the table that is listed on Pages 58 and 59. I believe I have copies of them that will be distributed to the conferees.

I will start out with the municipalities, first of all.

Carlton. The primary sewage treatment facilities were constructed in 1955. The recommended implementation schedule calls for construction of secondary facilities by December 1971 and effluent disinfection from May 1 through October of this year.

A letter was received from the village in December 1968 stating that the consulting firm of Ruble and Kaple had been employed to conduct the necessary studies for a preliminary report for secondary treatment. Monthly operation and effluent reports are being submitted. Chlorination of the plant effluent is being provided.

Cloquet. Primary sewage treatment facilities were constructed in 1957. The recommended implementation schedule calls for construction of secondary facilities by November 1973 and separation of combined sewers by June 1978. Chlorination of the sewage plant effluent is also required May 1 through October 31.

The city has signed an agreement with the P.C.A. to provide secondary treatment by November 1973. A letter from the city in January 1969 indicated that the City Engineer will proceed with studies on sewer separation and untreated sewage discharges. Monthly operation and effluent reports are being submitted, and effluent chlorination is being provided year round.

Duluth. Duluth has four primary sewage treatment plants. The main plant was completed in 1940 and the other three plants were completed in 1960. The recommended implementation schedule calls for construction of secondary and tertiary treatment plants by June 1972 and separation of combined sewers by June 1978. Effluent disinfection the year round is also required.

A preliminary report on secondary treatment was received from the city in July 1968. City representatives met with the P.C.A. staff in March 1969 and subsequently furnished a council resolution to proceed toward construction of secondary and tertiary facilities in accordance with the recommended schedule. It is understood that the city currently provides year-round chlorination at all of the plants and is proceeding on sewer separation projects. Monthly operation and effluent reports are furnished, as well as data from the city's stream sampling program.

Esko Township. The township has secondary sewage treatment facilities which were constructed in 1964. The existing treatment plant is considered to be generally adequate at this time and the township has indicated they will provide effluent disinfection May 1 through October 31, as required by the interstate water quality standards.

John P. Badalich

Floodwood. There is no sewage treatment provided at this time. The recommended implementation schedule calls for completion of secondary treatment facilities by December 1971, and separation of combined sewers by June 1978. Disinfection of the plant effluent must also be provided May 1 through October 31.

Plans have been approved and a permit has been issued by the Agency for construction and operation of secondary sewage treatment facilities. A recent letter from the village attorney indicates that any combined sewers or sewage sources not connected to a sanitary sewer would be corrected during the current improvement program.

Grand Marais. Primary sewage treatment facilities were constructed in 1940 and pre-aeration, chlorination, sludge storage, and sludge disposal were added in 1960. According to the implementation plan, secondary and tertiary facilities are to be constructed by December 1971, and separation of combined sewers is to be completed by June 1978. In addition, year-round disinfection of sewage effluent is to be provided.

Monthly reports on operation and effluent quality are being provided, and, according to reports, chlorination of effluent is being provided year-round.

Scanlon. The village presently has primary sewage treatment facilities with chlorination which were provided in 1941 and substantially improved in 1953. The recommended implementation schedule calls for secondary facilities to be provided by December 1971, and disinfection of plant effluent from May 1 to October 31.

Monthly operation and effluent quality reports are being furnished, and according to the reports chlorination of the sewage effluent was being provided in January 1969.

Silver Bay. The village has a secondary sewage treatment plant with cholorination which was constructed in 1953. According to the recommended implementation plan, secondary and tertiary treatment is to be provided by June 1972.

The existing plant is probably adequate at this time. Monthly reports on operation and effluent quality are being provided, and according to the reports effluent chlorination is being provided year-round.

Two Harbors. A primary sewage treatment plant with chlorination facilities was constructed in 1959. The recommended implementation schedule calls for construction of secondary and tertiary treatment facilities to be completed by December 1971. Separation of combined sewers is to be completed by June 1978.

The city retained engineers to make studies and prepare a preliminary engineering report for secondary and tertiary treatment in October 1968. A letter from the city in February 1969 indicates effluent chlorination facilities are in operation year round.

INDUSTRIES

Eveleth Taconite Company, Forbes. The industrial waste treatment facilities consist of a closed tailings basin system. The sanitary sewage is treated by secondary sewage treatment facilities constructed in 1965. The existing treatment facilities are apparently adequate. Monthly reports are furnished on the operation of the industrial waste treatment facilities.

Conwed Corporation, Cloquet. The sanitary sewage from this industry is discharged to the Cloquet sewer system. Fine screens and hot pond settling basins are provided for treatment of the industrial process wastewater.

In November 1968 the company signed an agreement with the Agency to provide adequate waste treatment facilities by November 1973. Operation reports are presently being provided to the Agency.

Northwest Paper Company, Cloquet. The sanitary sewage from this industry is discharged to the Cloquet sewer system. Waste treatment facilities for the process wastewater includes screens and flotation save-alls, lime sludge pond, foam barrier, mechanical clarifier, and the utilization of spent sulfite liquor for road binder.

In 1961 the company placed new Kraft mill evaporators and pulp washers in operation. In 1964 the company, along with other Cloquet area industries, as an experiment installed aeration units on the St. Louis River.

On November 12, 1968, the company signed an agreement with the Agency to provide adequate waste treatment facilities by no later than 1973. Reports of the effluent and operation are provided to the Agency.

John P. Badalich

Minnesota Power and Light Company, M. L. Hibbard Plant, Duluth. The sanitary sewage from the powerplant is treated by secondary sewage treatment facilities with chlorination. Presently wastewater treatment facilties consist of pneumatic ash recovery.

This company also controls the flow regimen of the lower St. Louis River through its hydroelectric power generating system. They have agreed to vent their turbines when the level of dissolved oxygen in the St. Louis River is low and to pass a minimum flow at all times.

Superwood Corporation, Duluth. Treatment of the sanitary sewage is by a septic tank with discharge to Superior Bay. Treatment of the industrial process waste is by settling ponds which also discharge to Superior Bay.

A filter unit was recently installed. Estimates are being prepared to compare the cost of discharging into the municipal sewer with that of providing treatment facilities, assuming an 80 percent, 5 day BOD reduction. The engineer stated in a letter dated December 4, 1968, that a report would be submitted early in 1969. Monthly effluent reports and quarterly progress reports are being submitted.

The recommended implementation schedule for construction of adequate sewage and industrial wasts treatment facilities and/or connect to the city sewer system is scheduled for December 18, 1971.

John P. Badalich

Reserve Mining Company, Silver Bay. The sanitary sewage is diverted to the Silver Bay secondary sewage treatment facilties. No treatment is provided for the industrial process wastes.

In reply to a letter from the MPCA with a recommended schedule for secondary treatment of plant process wastes,the company stated that they feel the requirement for secondary treatment or equivalent is not applicable to them and that their effluent does not pollute the lake. Monthly and semi-annual effluent and operation reports are being submitted to the Agency.

U. S. Steel Corporation, Duluth Works, Duluth. The sanitary sewage from the mill is presently treated by lagoon. Waste treatment facilities for the process wastewater consist of fly ash and oil recovery lagoons.

Plans for reconstruction of the existing waste treatment facilities were approved in April 1967.

Monthly reports of the effluent and operation are being provided to the Agency.

The recommended implementation plan calls for construction of adequate treatment facilities for the process wastewater by December 18, 1971.

Information obtained from the company at a meeting on May 8, 1969, indicates they are currently reviewing requirements of the standard, but have not reached a decision as to how they will proceed.

Mr. Chairman, this more or less sums up the abatement schedule and the compliance schedule of the municipalities and industrial wastes in the interstate waters that are tributary to the Lake Superior Basin.

MR. DOMINICK: Mr. Badalich, so that we might give the audience some indication of our schedule, how much more material do you have to present for the State of Minnesota?

MR. BADALICH: Mr. Chairman, getting into the list of participants or people who want to make a statement in the position of the State of Minnesota, I have some 33 different representatives who want to make a statement, and from looking at the time that is listed here, I would say it will probably take anywhere from 2½ to 3 hours.

MR. DOMINICK: We will have to discuss that with the other conferees. We have scheduled for today, for the afternoon, the other two States of Wisconsin and Michigan. I would suggest that we break for lunch at this point.

Yes, Mr. Frangos?

MR. FRANGOS: Just a question, Mr. Chairman.

As you know, Mr. Badalich, we are very much concerned with what is happening in the St. Louis River. And I am going to ask you, is it your opinion that if the abatement schedule that you have outlined for us is met, will the St. Louis River as it crosses the State line meet the Wisconsin water quality standards?

MR. BADALICH: It is my understanding, Mr. Frangos, that it would, based on the required dissolved oxygen in a river based on a consecutive---

MR. DOMINICK: I didn't hear your answer. Would or would not?

MR. BADALICH: I believe it would. The abatement schedule that we have set forth for the paper and pulp mill and also for the wood products plant, we feel it will meet the required standards.

MR. FRANGOS: Thank you.

MR. DOMINICK: Are there any other questions at this point?

Yes.

MR. PURDY: Mr. Badalich, in your report on treatment to be provided by certain municipalities you refer to tertiary treatment. What do you mean by tertiary treatment?

MR. BADALICH: Mr. Chairman.

Mr. Purdy, our standard indicates the phosphorus level shall be reduced to a level of 2 milligrams per liter, and that is what we refer to as tertiary treatment.

MR. PURDY: Thank you.

MR. DOMINICK: I would suggest that we break for lunch at this point and return at 1:15.

The Chair will reopen this conference at 1:15 promptly, and I would like to have the conferees here at that time.

(Whereupon, at 12:05 p.m., the conference recessed until 1:15 p.m.).

AFTERNOON SESSION

MR. DOMINICK: The conference will come to order, please.

I would like to describe for the benefit of everyone here what we have agreed to as a tentative schedule for the remainder of the conference. This afternoon we will start with all governmental witnesses from the State of Minnesota. Then we will move to the State of Wisconsin and hear all witnesses from the State of Wisconsin. Following that the State of Michigan will make its presentation. We will go as late into this evening as appears appropriate, and whether we get into any Michigan testimony today or not is still a question.

However, following the close of all Michigan testimony, we will hear from other Federal agencies. Following that, we will hear from all other interested citizens who have not yet had an opportunity to appear.

Speaking as the Chairman, I would like to plan to conclude this portion of the conference by tomorrow evening. We would like to get this wound up and finished without having to go on into Friday.

With that as a tentative agenda before us, we will proceed with the State of Minnesota.

Before we do, I have one question to address to Mr. Badalich.

I note, Mr. Badalich, that in the presentation which you gave just before lunch, under Reserve Mining Company, Silver Bay, you said that, quote:

> 'In reply to a letter from the MPCA with a recommended schedule for secondary treatment of plant process wastes, the company stated that they feel the requirement for secondary treatment or equivalent is not applicable to them and that their effluent does not pollute the lake." End quote.

In addition, I note on Page 59 of the report before us under "Status of Industrial Waste Discharges (As of March 1, 1969)" for the State of "Minnesota" the Reserve Mining Company has listed as a date for abatement schedule December 18, 1971. Would you clarify for the record these matters and provide for the record when it is available to you the correspondence that you mentioned in your previous testimony?

MR. BADALICH: Mr. Chairman, I would very gladly provide you the correspondence. I am sorry, we did not bring that along at this particular time. But the matter that you referred to is following the procedures of our interstate water quality standard setting procedure. Besides the standard, we also have the implementation plan and the compliance schedule. This letter was sent to all the dischargers on interstate water throughout the State of Minnesota, not only the Lake Superior Basin but all other dischargers on interstate waters. In order to implement our water quality standards abatement programs these letters were sent out as soon as we got the verbal O.K. from the Department of the Interior that our interstate water quality standards were going to be approved. In order to maintain a time schedule that we felt was in the implementation plan, these letters were sent out, and Reserve Mining, also being on interstate waters, was sent a letter. This indicated in the event that there was any organic waste from their process waste they were obligated to provide secondary treatment and also chlorination.

The letter in return from the company indicated that their process waste is inorganic material and that they do not feel they would then be subject to the interstate standards or to this letter of compliance.

(A copy of the letter follows)

MR. DOMINICK: Thank you very much.

You may proceed with your statements.

MR. BADALICH: Mr. Chairman, as agreed upon by the conferees, I will call upon the governmental agencies that have requested an appearance. These are as follows, so if you could be ready in this order:

Mayor Shearing, of Silver Bay; Richard Mahal, of Babbitt; Axel Jensen, the Water Department of Silver Bay; Mr. Robert Hanson, Chairman of the Lake County Board of Commissioners; Mr. Lloyd Shannon, County Commissioner of St. Louis Board of County Commissioners; and

RESERVE MINING COMPANY
SILVER BAY, MINNESOTA 55614

E. M. FURNESS
PRESIDENT

October 10, 1968

Mr. John P. Badalich, Director
Minnesota Pollution Control Agency
459 Board of Health Building
University Campus
Minneapolis, Minnesota 55440

Dear Mr. Badalich:

We have received your letter of September 17, 1968, relative to possible secondary treatment of wastes discharged into interstate waters.

Reserve Mining Company discharges no sewage into interstate waters. The sewage from the taconite plant at Silver Bay goes into the sewage treatment plant of the Village of Silver Bay where--along with the municipal sewage--it receives both primary and secondary treatment before discharge into the lake.

Reserve discharges the "tailings" from its processing onto the beach at Silver Bay. This discharge spreads over the beach and a portion of it flows into Lake Superior. This is done under permits issued by the Minnesota Water Pollution Control Commission (the predecessor of the Minnesota Pollution Control Agency), the Commissioner of Conservation of the State of Minnesota, and the Corps of Engineers of the U. S. Army. The whole method of processing and treatment and discharge was thoroughly considered by these agencies when these permits were issued originally and when subsequently amended in recent years.

The taconite (one of the hardest rocks found on the surface of this continent) treated at this plant is crushed and ground to the fineness necessary for the separation of the iron bearing particles--called "concentrate"--from the crude taconite. This separation is achieved by gravity and magnetic processes. The remainder of the rock, called "tailings," is nothing but sand --a very dense, insoluble, inorganic sand. (Reserve's discharge does contain a comparatively small amount of fly ash which is pumped from the power plant into the tailings discharge stream during the winter months only, under a special temporary or revocable permit issued in recent years specifically for this purpose.)

The beach--or delta--upon which the water-borne tailings are deposited is located outside of Reserve's harbor on the easterly side of the east breakwater at Silver Bay. The coarse particles settle on the delta; the fine particles are carried by the water over the delta to the lake. Because this water containing the particles is heavier than the lake water, it flows down under the lake water along the incline of the delta's face as a "heavy density current," and then along the lake bottom to the great depths of the lake where the fine particles of sand settle out. Reserve's discharge is similar to those of many rivers which in their natural state have flowed into Lake Superior for centuries without injury to the water, except that those rivers have carried greater loads of much finer materials--clays, silts, sands, decayed vegetation, etc.

Of course, Lake Superior is so deep and large that even if natural mixing or dispersion of sediments were a significant factor, there would be no adverse effect upon the quality of the water. However, the heavy density current performs so effectively that water samples taken within ten to twenty feet from the point where Reserve's discharge enters the lake consistently show that the water's quality will easily meet the highest criteria prescribed by state or federal authorities and, in fact, show that no changes in quality have occurred.

On numerous occasions, representatives of your agency as well as other state and federal agencies have inspected Reserve's operations and investigated our use of Lake Superior. We have given full cooperation in connection with such investigations, and have participated in various studies conducted by those agencies as well as carrying on our own extensive studies. These investigations and studies have demonstrated that the tailings contain no acids or offensive matter, are not bio-degradable wastes, and that no program for secondary treatment is necessary, required by law, feasible, or would serve any useful or advantageous purpose.

Sincerely,

EMF/paa

the St. Louis River Water Quality Committee, which consists of a group of citizens, an official committee of the city of Cloquet; Northwest Paper and Conwed Paper regarding the St. Louis River-Cloquet situation.

If I may call on Mayor Shearing from Silver Bay to make his presentation.

STATEMENT OF THE HONORABLE FRANK SHEARING,
MAYOR, SILVER BAY, MINNESOTA

MAYOR SHEARING: Thank you, Mr. Chairman.

Conferees, ladies and gentlemen:

My name is Frank Shearing and I am Mayor of the town that has been discussed, which is a short distance from the shores of Silver Bay. I might add I am rather proud of the fact that I am.

For the past year the subject of water pollution has been a topic of conversation in almost every group meeting in our area. Numerous industries, communities, and public services have been accused of contributing to the pollution of Lake Superior, and it goes without saying that Reserve Mining Company is probably receiving more attention than any of them.

As a representative of the village government of Silver Bay, I can assure you that none of us are experts in settling water pollution. We do feel, however, we are qualified to determine what is best for the welfare of our community. Previous mayors and councils have stated that they would be opposed to dumping tailings in the inland area. The present village Council concurs with this for several reasons.

First of all, it could constitute a serious hazard if the flash floods or heavy rainfall were to cause a rupture in the dike and this material would slide down below into Beaver Bay causing injury or damage.

Secondly , we feel an area such as this would not be conducive to the beautiful trout streams and works of nature that are now in that area.

There have been statements to the effect that dead fish are found in abundance in the area that is supposedly being polluted. From personal observation, the only dead fish I have seen in this area are numerous smelt that have been cast upon the shores of our lake by inconsiderate fishermen. In almost every case, newspaper articles mention "Silver Bay" or "Reserve Mining Company" or "taconite tailings" as the prime source of pollution in Lake Superior. Very rarely do they mention the other sources of pollution in the Wisconsin Basin or the other sources of pollution along the Canadian shore, nor do they suggest that the majority of the communities and resorts along the North Shore might also be contributing to the pollution of Lake Superior.

Honorable Frank Shearing

To set the record straight, the village of Silver Bay does not condone pollution by anyone or for any reason. We do suggest, however, a decision of this conference could have long-lasting effects and possibly be detrimental to that which we seek to achieve at this conference. I am convinced that only through open-minded discussions and greater thinking can we accomplish that which is necessary.

It is my opinion that some of our present-day procedures governing pollution might still be in the horse and buggy era in this area. And I suggest that possibly the pumping of ballast, both domestic and foreign, in our lake is probably not being governed as it should be. I know this from personal observation. I have seen it happen. I think groups such as this conference are attempting to act in this direction.

In order to do a proper job, I think they need the support of our patience rather than the demands of our criticisms. And, above all, none of us should seek in an issue such as this for personal recognition for some future endeavor that we might attempt to accomplish.

Most of us have read or listened to articles in the newspapers. We have listened on television to political figures and leadgers or groups of associations as they condemn one industry for polluting the lake and fail to suggest there might be others. We don't need Senators to tell us - I have seen it with my own eyes - that pollution is happening and to look at that glass of water and tell me it is polluted. Consequently, in Minnesota we have to employ scientists and biologists to determine whether pollution is happening or not. And that is how it should be. If we fail to rely on scientific findings, it would seem to me that we are making decisions on a very shaky ground. Along this same line, we should consider all the facts, not those just suitable for our own personal desires.

In conclusion, I would like to restate the position of the Mayor and Council of Silver Bay. When a responsible organization such as the Department of the Interior or the Federal Water Pollution Control Administration or the Minnesota Pollution Control Agency presents us with positive facts or evidence that serious pollution is occurring, we will then reconsider our position and take action accordingly. On the supposition, it would be only foolhardy on our part to do otherwise. It would only add to the number of Excedrin headaches being suffered by the Commissioners for a job that is fair and equitable to all.

Thank you very much.

(Applause.)

MR. BADALICH: Thank you, Mayor Shearing.

I would like to call upon the Mayor or the representative of the village of Babbitt. I have no name here.

Honorable Richard Mahal

STATEMENT OF THE HONORABLE RICHARD MAHAL,

MAYOR, BABBITT, MINNESOTA

MAYOR MAHAL: Thank you, Mr. Chairman.

Conferees, members of the press, ladies and gentlemen of the conference:

MR. BADALICH: Would you identify yourself, sir.

MAYOR MAHAL: My name is Richard Mahal. I am the Mayor of Babbitt.

In behalf of the Village of Babbitt and the Babbitt Area Business and Professional Association I would like to submit the following statement for the consideration of the Federal and State water pollution agencies:

The Village of Babbitt is located about 17 miles south of the Canadian border near Ely, Minnesota. Here is where taconite is mined to be transported 47 miles to Silver Bay for its beneficiation and production into pellets.

We do not argue, nor do we presume to be knowledgeable on issues centering on Lake Superior pollution.

We do, however, wish to state emphatically that it is not consistent with Reserve policies, as we know them, to overlook any phase of our community's health and welfare.

Certainly, no taconite company on the entire Iron Range has done more for the community in which it is located than Reserve Mining Company. Reserve has consistently proven its civic-mindedness through continued cooperation with our people in a multitude of projects.

We sincerely believe that Reserve with its outstanding record of community help and involvement has consistently striven wholeheartedly to improve our community and the surrounding area.

Because Babbitt, with 615 homes and a population of 4,000 (and, for that matter, all peripheral communities) are heavily dependent upon Reserve for employment, we consequently cannot emphasize too strongly the immeasurable impact of this taconite producer on our area. Reserve's 1968 annual payroll of $29.4 million, over half of which is paid to the Babbitt division, is almost the sole monetary factor governing our economic well-being. For this reason we in Babbitt cannot afford any interruption in Reserve's operation.

Our school system, which represents an expenditure by Reserve of $7,365,000 is tops in the State if not the Nation. The people of Babbitt enjoy the finest facilities available and are humbly proud of the beautiful buildings built by Reserve which more than meets its obligation to the educational needs of Babbitt.

This fine educational system, staffed by a total of 109 employees, represents a payroll of $766,000 for the 1968-1969 school year.

Reserve has always been interested in people. This fact becomes clearly evident in the varied business, civic, and social projects this company has cooperated with in providing the best possible living and working conditions for its people and for the entire Village of Babbitt.

The following examples of community improvement will serve to illustrate the overall trend Reserve Mining Company has initiated relative to the health and welfare of our people:

1. A smoothly operating and efficient village water plant and sewer system (primary and secondary treatment), generously assisted by Reserve through the years, indicates firsthand the company's concern in maintaining the highest standards of health and safety.

2. The Babbitt Clinic is staffed by Reserve medical personnel 24 hours a day. This facility provides modern medical and dental services for its people.

3. Reserve Mining Company has provided the Babbitt citizens with a community building which can be used free of charge for the various community meetings and activities which take place during the year.

4. Our modern recreation center was donated and remodeled by Reserve, which provides a marvelous facility for our growing population.

5. Our clean, safe public beach exemplifies the concern of Reserve to provide better than adequate facilities for the families of Babbitt.

6. The beautiful Babbitt Golf Course again speaks loud and clear about the responsibilities Reserve has shouldered to make Babbitt a better place in which to live, work, and play.

7. We have a new, ultra-modern ice arena in the Village. The people of Babbitt have also invested in a new fire hall, municipal garage, six churches, and other buildings in the last 2 years. Babbitt's pride in their community is illustrated by continual improvement and beautification of homes, which are all privately owned. A new public library is now in the planning stages.

Reserve has contributed immensely to the economic picture of northeastern Minnesota. They are essential to the area. Reserve deserves your utmost and objective consideration without emotional or political motives.

Thank you for your time and consideration.

(Applause.)

MR. BADALICH: Thank you, Mayor Mahal.

Next, I would like to call on Mr. Axel Jensen, Water Superintendent of Silver Bay, Minnesota.

STATEMENT OF AXEL A. JENSEN,
WATER SUPERINTENDENT,
SILVER BAY, MINNESOTA

MR. JENSEN: Thank you, Mr. Chairman.

Conferees and ladies and gentlemen:

The testimony I am presenting is taken from, and documented by, the operating records of the Silver Bay Water Treatment Plant.

Axel A. Jensen

The source of our municipal water supply is Lake Superior and our intake is located less than a mile from Reserve Mining Company's taconite tailings discharge.

Our water treatment plant began operations in 1953 several years before Reserve Mining Company began operations.

There are two rapid sand filters in our treatment plant. The function of these filters is to remove any suspended material contained in Lake Superior water. As these fine suspended materials accumulate on the surface of the filter, they increase in density and gradually decrease the rate at which water will filter through this dense layer. Accumulation and density on the filter surface is measured by a loss of head-gauge. When the filter has reached the pre-determined head loss, backwashing of the filter is necessary.

All backwashings of the sand filters have been recorded since our plant began operations. Our records show that the amount of water filtered between backwashings from year to year is the same today as it was in 1953. A definite indication that there has been no increase in suspended materials in Lake Superior.

Daily turbidity measurements are also made on filtered and unfiltered water. Our records show that no increase in turbidity has been noted.

Samples of Lake Superior water have been collected and tested for absence or presence of coliform bacteria every two weeks since 1964. Again our records show that there has not been the slightest increase in most probable number of coliform bacteria per 100 ml.

Statements made that there is an increase in suspended materials or turbidity because of Reserve Mining Company's discharge are not substantiated by our records.

Thank you.

(Applause.)

MR. BADALICH: Thank you, Mr. Jensen.

Next, I would like to call upon Mr. Robert Hanson, Chairman of the Lake County Board of Commissioners.

(No response.)

MR. BADALICH: I guess he is not here.

Next, Mr. Lloyd Shannon, County Commissioner, St. Louis Board of County Commissioners.

STATEMENT OF A. LLOYD SHANNON
COUNTY COMMISSIONER, ST. LOUIS
COUNTY, MINNESOTA

MR. SHANNON: Mr. Chairman, guests, ladies and gentlemen:

I am Lloyd Shannon, member of the Board of County Commissioners in St. Louis County.

At our regular Board meeting this resolution was passed unanimously:

WHEREAS, A sufficient number of studies and conclusions have been made, determining that there are indeed serious pollution problems existing in our rivers, streams, inland lakes, and St. Louis Bay of St. Louis County, some of which contribute to the pollution of Lake Superior and

WHEREAS, The implementation of present technical knowledge and enforcement of present laws and regulations would assure a program that will guarantee unpolluted lakes and streams for future generations to use and enjoy;

NOW, THEREFORE, BE IT RESOLVED, That the Board of County Commissioners of St. Louis County, duly assembled in regular session this 12th day of May 1969, hereby urges the Minnesota Pollution Control Agency to seek the funds and manpower to implement a statewide program immediately that will halt the polluting of the waters of Minnesota.

Perhaps this resolution would appear that the concern is for only the people of Minnesota. It is not. We recognize that we are a part of the problem of Lake Superior and to find a cure we must get to the source.

We look mainly to the Minnesota Pollution Control Agency for guidance and assistance, and we believe that any program which is to have far-reaching effects and results must go beyond local efforts. This is why the County Board urges a State and Federal action program supported and enforced by them, for without more than the policy-making agencies of higher government telling us what to do, yet do not themselves become directly involved, it is impossible that the problems shall ever be corrected.

Therefore, we ask that this hearing be not a compiling of words, testimony, and promises bound in book form and then filed upon some shelf, as sometimes seems to be the case, but that it will be a real beginning to save our rivers, streams, and lakes.

Thank you.

(Applause.)

MR. BADALICH: Thank you, Mr. Shannon.

I guess Mr. Hanson is here from the Lake County Board of Commissioners.

STATEMENT OF ROBERT HANSON
CHAIRMAN, BOARD OF COMMISSIONERS,
LAKE COUNTY, MINNESOTA

MR. HANSON: Mr. Chairman, members of the Commission, ladies and gentlemen:

I am Robert Hanson, Chairman of the Lake County Board of Commissioners. I have a resolution that the Board adopts that I would like to read.

WHEREAS, the Reserve Mining Company, with installations at Silver Bay in Lake County, Minnesota, and Babbitt in St. Louis County, Minnesota, pioneered in the development and establishment of the taconite industry in Minnesota, and;

WHEREAS, as a result, in excess of one billion dollars of private capital has been invested, and thousands of permanent jobs have been created in an area which otherwise appeared to be without hope for any future progress or recovery, and;

WHEREAS, before making said expenditure, or commencing said construction work, the officers and directors conducted extensive research; and attended hearings and offered testimony before the Commissioner of Conservation of the State of Minnesota in St. Paul, as well as other places, for the purpose of definitely determining that Reserve would be permitted to expend tailings into Lake Superior without harm to the lake or its fish, and;

WHEREAS, the policy of Reserve has been one of continued caution and concern, so as to prevent any such harm to the lake or damage to the fish,

RESOLVED, AS FOLLOWS BY THE LAKE COUNTY, MINNESOTA, BOARD OF COUNTY COMMISSIONERS:

1. That the County Board expresses its gratitude to Reserve Mining Company for the development, construction and maintenance of the facilities at Silver Bay and Babbitt, and for the contribution this development is making to this area.

2. That the Reserve Mining Company, in expending a half a billion dollars of its own money and creating permanent employment for thousands of men in a depressed area, is entitled to praise, rather than criticism.

3. That the taconite projects in Minnesota represent only a small percentage of the taconite plants, in operation or being constructed, in the rest of the world; thus creating ever-increasing competition for the Minnesota companies.

Robert Hanson

4. That the matter of the tailings in Lake Superior be considered in its proper perspective, and at the same time and in the same manner and degree, as other industrial or commercial wastes.

5. That the consideration and investigation be broad and fair enough to include industries, in both Minnesota and Wisconsin, located on both Lake Superior and Lake Michigan, and Canada.

6. That the County Board favors a continuing study of all pollution problems, both air and water, in all of these areas.

7. That certified copies of this resolution be furnished to the Chairman of the Lake County Board of Commissioners for presentation to the Minnesota Pollution Control Agency Hearing to be conducted on May 13; to Congressman John A. Blatnik; and to Reserve Mining Company.

Commissioner Houle moved the adoption of the foregoing resolution and the same was declared adopted upon the following vote; Yeas, Houle, Marklund, Hanson, Ferguson, and Hanson. Total years, five. Nays, none.

(Adopted May 12, 1969) 69-127

State of Minnesota)
)ss.
County of LAKE)

I, MelRoy Peterson, auditor of Lake County, Minnesota, do hereby certify that I have compared the foregoing resolution with the original filed in my office on the 12th day of May, 1969, and that the same is a true and correct copy of the whole thereof.

WITNESS my hand and seal of office at Two Harbors, Minnesota, this 12th day of May, 1969.

MelRoy Peterson
Auditor, Lake County, Minnesota

SEAL

State of Minnesota

Thank you very much.

(Applause.)

MR. BADALICH: Thank you, Mr. Hanson.

Next, I would like to call on the representative of the St. Louis River Water Quality Committee

STATEMENT OF WALLACE JOHANSON
CITY COUNCILMAN, CLOQUET, MINNESOTA:
CHAIRMAN, CLOQUET-ST. LOUIS RIVER
WATER QUALITY COMMITTEE.

MR. JOHANSON: I am Wallace Johanson, Cloquet City Councilman and Chairman of the Cloquet-St. Louis River Water Quality Committee. Cloquet is a city of about 10,000 located 20 miles west of

Duluth on the St. Louis River, a tributary of Lake Superior. Two of the industries located within Cloquet are The Northwest Paper Company and Conwed Corporation, whose effluent along with that of the city of Cloquet constitutes the major source of pollution on the St. Louis River above Fond du Lac.

The people and industries of Cloquet have recognized the need for and have attempted to determine economically feasible means of treating industrial waste and municipal sewage so as to not pollute the St. Louis River. Both Conwed Corporation and The Northwest Paper Company have conducted research and have, in conjunction with the City of Cloquet, searched every available means to achieve this end.

As part of this continued research and study, The Northwest Paper Company and Conwed Corporation retained the highly respected consulting engineering firm of Quirk, Lawler and Matusky of New York City early in 1965 to determine the sources and amounts of pollution material in the St. Louis River and to determine the problems involved in maintaining alternative levels of water quality in the river. Field studies were conducted by Quirk, Lawler and Matusky and a mathematical simulation model of the river was constructed recognizing inputs and outputs and reaction phenomena.

On December 12, 1967, a 24-page summary report of this engineering work was presented to the Minnesota Pollution Control Agency.

Wallace Johanson

This report indicated that there were numerous difficulties involved in maintaining the oxygen level in the river due to the natural biochemcial oxygen demand and the depressed oxygen content of the water entering Cloquet as well as those due to the several stream impoundments located below the city.

Early in 1968 the city of Cloquet joined with the Northwest Paper Company, Conwed Corporation, the Village of Scanlon, the Carlton County Commissioners and Minnesota Power and Light Company in the Cloquet-St. Louis River Water Quality Committee. This committee coordinates pollution studies and abatement measures and acts as liaison between the concerned industries, the city of Cloquet and the various government agencies, principally the Minnesota Pollution Control Agency.

In a series of meetings with the Minnesota Pollution Control Agency and the Federal Water Pollution Control Administration, it was agreed that the water quality of the St. Louis River should be upgraded as rapidly as possible. To achieve this, the city of Cloquet, Conwed Corporation, and The Northwest Paper Company voluntarily agreed to make the changes and install the treatment facilities necessary to meet the requirement of equivalent secondary treatment as rapidly as possible.

The meetings between the four parties arriving at a solution to the problem were marked by close cooperation and harmonious exchange on all sides. The agreement was reached, was signed by the two industries and the city of Cloquet, and by the Minnesota Pollution Control Agency on November 12, 1968.

This agreement established a time schedule for completion of the various phases of construction of the treatment facility to be in operation. This agreement is now being implemented and laboratory scale treatment studies are now under way to determine whether joint or independent treatment of the effluent is necessary from a financial and technical standpoint.

This, then, is how a fair and equitable means of achieving the clean waters desired by everyone was reached. Through the cooperation and assistance of industry, municipal government, and the State of Minnesota, the St. Louis River will have the degree of water purity consistent with the best uses of the water insofar as the reach of the river affected by Cloquet is concerned.

(Applause.)

MR. BADALICH: Thank you, Mr. Johanson.

Mr. Chairman, I believe this concludes the Minnesota presentation insofar as the governmental agencies are concerned.

MR. STEIN: I understand the procedure is to call on Wisconsin now.

May we have Wisconsin, Mr. Frangos.

MR. FRANGOS: Mr. Chairman, we are prepared to proceed with our presentation at this conference.

I would first like to call on Mr. Francis Schraufnagle of the Division of Environmental Protection to present the statement of the Wisconsin Department of Natural Resources.

Axel A. Jensen

The source of our municipal water supply is Lake Superior and our intake is located less than a mile from Reserve Mining Company's taconite tailings discharge.

Our water treatment plant began operations in 1953 several years before Reserve Mining Company began operations.

There are two rapid sand filters in our treatment plant. The function of these filters is to remove any suspended material contained in Lake Superior water. As these fine suspended materials accumulate on the surface of the filter, they increase in density and gradually decrease the rate at which water will filter through this dense layer. Accumulation and density on the filter surface is measured by a loss of head-gauge. When the filter has reached the pre-determined head loss, backwashing of the filter is necessary.

All backwashings of the sand filters have been recorded since our plant began operations. Our records show that the amount of water filtered between backwashings from year to year is the same today as it was in 1953. A definite indication that there has been no increase in suspended materials in Lake Superior.

Daily turbidity measurements are also made on filtered and unfiltered water. Our records show that no increase in turbidity has been noted.

Samples of Lake Superior water have been collected and tested for absence or presence of coliform bacteria every two weeks since 1964. Again our records show that there has not been the slightest increase in most probable number of coliform bacteria per 100 ml.

STATEMENT OF FRANCIS H. SCHRAUFNAGEL,
DIRECTOR, BUREAU OF STANDARDS AND
WATER SURVEYS, DEPARTMENT OF NATURAL RESOURCES,
STATE OF WISCONSIN, MADISON, WISCONSIN

MR. SCHRAUFNAGEL: Thank you, Mr. Chairman.

Ladies and gentlemen:

My name is Francis H. Schraufnagel. I am Director of the Bureau of Standards and Water Surveys, Department of Natural Resources, State of Wisconsin, Madison.

My report is intended as a summary of the actions taken and initiated the past 4 years by the Wisconsin Department of Natural Resources, its predecessors and cooperating agencies in decreasing the pollution and improving the water quality of that portion of the Lake Superior Basin within the State boundaries.

In 1965-1966 a comprehensive survey was made of the Wisconsin sources of pollution in the Lake Superior watershed. Some 40 potential pollution sources were investigated. Survey findings were discussed under "Report on and Investigation of the Pollution in the Lake Superior Drainage Basin Made During 1965 and Early 1966," dated April 28, 1966. Shortly thereafter a hearing was held at Ashland to present the findings and provide industrial and municipal spokesmen and others an opportunity to testify concerning what is being done and should be done about pollution in the basin.

Francis H. Schraufnagel

In response to requirements of the Federal Water Quality Act, hearings were held on April 5 and 6, 1967, at Superior and Hurley, respectively, regarding interstate water quality standards for Lake Superior. The interstate water quality standards were approved by the Resource Development Board on April 26, 1967, and after publication became effective on June 1, 1967. The standards and a plan for their implementation were submitted that month to the Secretary, Department of the Interior, and approved as Federal-State standards in January 1968. A listing of Wisconsin pollution sources on interstate waters of the Lake Superior Basin with their approved pollution abatement schedules is attached as Appendix A.

(Appendix A follows:)

Industry or Municipality	Mileage (a)	Type of Waste	Treatment (b)	Additional Requirements	Schedule
			LAKE SUPERIOR		
Superior Fiber Products, Inc., Superior	147.3	Paper	Screening & Lagoon	Adequate Treatment	10-1-70
Superior, City of	146.0	Sewage	Primary & Disinfection	Secondary Treatment Combined Sewers Problem	10-1-70 10-1-77
Booth Fisheries Div., Consolidated Foods Corp., Bayfield	55.3	Fish Processing	None	Adequate Treatment or Disposal	10-1-70
Sand Bay Fisheries, Bayfield	55.2	Fish Processing	None	Adequate Treatment or Disposal	10-1-70
Bodin Fisheries, Bayfield	54.8	Fish Processing	None	Adequate Treatment or Disposal	10-1-70
Bayfield, City of	54.5	Sewage	Primary & Disinfection	Secondary Treatment Clear Water Problem	10-1-70 10-1-77
Pureair Sanatorium, Bayfield	52.5	Sewage	Septic Tank & Absp. (Overflows)	Adequate Treatment	10-1-70
Washburn, City of	41.0	Sewage	Primary & Disinfection	Secondary Treatment Clear Water Problem	10-1-70 10-1-77
E. I. du Pont de Nemours & Co., Barksdale	37.5	Chemical	Land (Overflows)	Adequate Treatment or Disposal	10-1-70
Ashland, City of	31.4	Sewage	Primary & Disinfection	Secondary Combined Sew. Prob.	10-1-70 10-1-77
American Can Co., Ashland Division	29.4	Paper	Chemical Coagulation & Water Reuse	Pending Install. of Supplementary Equip.	
			MONTREAL RIVER		
Hurley, City of	22.4	Sewage	Primary 12%	Secondary Disinfection Clear Water Problem	10-1-70 5-1-68 10-1-77

Francis H. Schraufnagel

Hearings for the establishment of intrastate water quality standards were held at five locations in November 1967. Intrastate standards and designated use classifications were adopted by the Board in June 1968 and became effective on September 1, 1968.

On February 21, 1968, orders were issued to pollution sources in the Lake Superior Basin requiring adequate treatment facilities. The bases of the orders were the pollution report and hearing of 1966 and the Federal-State water quality standards for interstate waters and the plan for their implementation. Remedial action that is required by the Department has been provided to the Federal Water Pollution Control Administration to assist in preparation of the report that will be presented at the conference. Water quality standards for both interstate and intrastate surface waters within the Wisconsin section of the Lake Superior Basin and classification of the waters involved are attached as Appendix B.

(Appendix B is as follows:)

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
INTERSTATE WATERS-USES AND DESIGNATED STANDARDS
(LAKE SUPERIOR BASIN)

APPENDIX B

RD 3.03 Wisconsin-Minnesota Waters

The St. Louis River adjoining Wisconsin is used for recreation, fishing, waste assimilation and commercial shipping. It is anticipated that a future use in the Lower St. Louis River will include cooling and industrial water supply. The St. Louis River water quality should meet all standards except for public water supply.

RD 3.04 Wisconsin-Minnesota-Michigan Waters

Lake Superior is used for recreation, commercial and recreational fishing, shipping, municipal water supply, industrial and cooling water, and waste assimilation. Lake Superior open waters should meet the criteria and requirements for all water uses. Harbor areas and shoreline sections in the vicinity of pollutional outlets should meet minimum criteria plus requirements for cooling and industrial water supply. Beach waters of Lake Superior should meet the standards for whole body contact recreation.

RD 3.05 Wisconsin-Michigan Waters

The Montreal River is used for hydropower, recreation, wildlife and stock watering, waste assimilation and has aesthetic value. Its waters should meet the quality standards and requirements for all water uses except for a sector extending from upstream limits of the city of Hurley to a point downstream five miles below the city limits where the water quality and requirements should be suitable for partial body contact recreation and fish and aquatic life.

INTRASTATE WATER QUALITY STANDARDS AND USE CLASSIFICATIONS

RD 4.01 Goals

Water Quality Standards for intrastate surface waters will be the same as those that have been adopted for interstate waters, Wis. Adm. Code, chapter RD2.

The long-range goal of Wisconsin water standards is to permit the use of water resources for all lawful purposes. It is equally a goal of the standards to restore and maintain the waters of the state as suitable for public water supply, whole body contact recreation, and the reproduction of game fish and minnows. It is the working objective of the department to achieve these goals within 10 years. Standards and use classifications which are presently inconsistent with the long-range goals are interim standards and use classifications and will be progressively upgraded until the goals are attained.

RD 4.05 Standards applicable to region 4

The following surface waters must meet minimum standards and those for public water supply in addition to the standards for recreational use, and fish and other aquatic life:
(a) Lake Lavina in Iron county.

RD 4.06 Standards applicable to region 5

Intrastate surface waters of region 5, consisting of Douglas, Bayfield, Ashland, ... Counties, shall meet the standards for recreational use, and fish and other aquatic life, with these exceptions and additions:
(1) The following surface waters must meet minimum standards:
(a) Newton Creek in Douglas county.
(b) Boyd Creek in Bayfield county for 1.6 miles above its mouth.

WISCONSIN WATER QUALITY STANDARDS*

Preface

Water quality standards are statements of the characteristics of a water which must be maintained to make it suitable for specified uses. The standards are meaningful for pollution control when applied to specific waters, such as a lake or stretch of river.

The standards are based on available scientific knowledge and have been referred for comment to health authorities, fish and wildlife biologists and other interested professional persons. As knowledge increases the standards will be modified to reflect such increased knowledge.

These water quality standards are the present goal. The ultimate goal shall be to permit use of all the water resources of the state for multiple purposes including aesthetic, agriculture, aquatic and wildlife, industry, potable water supply, hydropower, navigation, recreation, and controlled waste assimilation.

Public hearings were held to elicit citizens' views on the standards. A second purpose of the hearings was to ascertain the popular wishes as to the use of specific areas of lakes and streams.

The Department of Natural Resources will determine what must be done in each case to obtain the necessary water quality and the time schedule which may be set realistically to achieve it. As technology permits, classification of waters will be reevaluated to reflect these advances.

Feasible uses and a realistic schedule are essential to strong enforcement. The Department now monitors state waters and plans more frequent sampling of both surface and waste waters as rapidly as it gains the manpower and equipment.

Requirements

The Federal Water Pollution Control Act of 1965 specifies that each state file a letter of intent and, after hearings and before June 30, 1967, adopt water quality criteria and a plan for applying them to interstate waters within the state. Such criteria and plan if consistent with the Act thereafter will be the applicable interstate water quality standards.

In establishing such standards, consideration has been given to their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses.

Chapter 614, Wisconsin Laws of 1965, became effective on August 1, 1966 and authorized and directed the adopting of rules setting standards of water quality. It recognized that different standards may be required for different waters or portions thereof. The intent is set forth: ". . .standards of quality shall be such as to protect the public interest, which include the protection of the public health and welfare and the present and prospective future use of such waters for public and private water supplies, propagation of fish and aquatic life and wildlife, domestic and recreational purposes, and agricultural, commercial, industrial and other legitimate uses. In all cases where the potential uses of water are in conflict, water quality standards shall be interpreted to protect the general public interest."

The Governor, in August 1966, notified the Secretary of the Interior that Wisconsin intends to establish Interstate Water Quality Standards by June 30, 1967.

Present and possible uses of interstate waters or sections therein have been determined with respect to: Municipal, industrial, cooling, irrigation, wildlife and stock water supply; tolerant, facultative and intolerant fishery; whole and partial body contact; aesthetics, hydropower, commercial shipping and waste assimilation. Water quality standards for the following categories are considered: Public Water Supply, Recreation, Industrial and Cooling Water Use, Fish and Other Aquatic Life, and Minimum.

Implementation and Enforcement

Wisconsin legislation requires the formulating, periodic updating and carrying out of long-range comprehensive plans to guide the development, management, and protection of water resources. The initial plans must be drawn up by July 1, 1968. Statutes authorize issuance and adoption of rules with regard to available systems, and methods and means for preventing and abating water pollution. Orders not complied within the time specified must be referred to the Attorney General for prompt commencement of an action. Penalties are provided for not complying with the law, rules and orders. Assessments for fish damages and fines will continue to be used to curb discharges of deleterious substances and to handle intermittent pollution problems.

Wisconsin has been systematically making pollution surveys and monitoring the surface water quality of its major streams. The state is increasing the frequency of and expanding the surveys. Funds have been made available for this purpose. Although surface water quality standards are set forth herein, it may be necessary in individual cases to stipulate effluent quality requirements in order to achieve the stated objectives.

A state financial assistance program has been authorized to encourage municipalities to construct new or improved pollution prevention and abatement facilities. Legislation provides that industry may acquire land by condemnation for construction of waste disposal facilities. Tax laws permit writing off waste treatment plant construction costs in the year of expenditure and exemption of these facilities from real estate tax.

Financial assistance, industrial incentives, increased surveillance, orders and legal action will be the means used to implement and enforce the adopted water quality standards. Reasonable time schedules to comply with orders depend on the circumstances. In general, 1 year to provide disinfection, in-plant controls and minor treatment adjustments; or 2 years to install settleable solids removal facilities; or 2-3 years to complete a secondary treatment system should be adequate. Separation of excessive clear waters from sanitary sewerage systems may vary from 1 year for disconnection of roof leaders to 10 years or more where combined sanitary-storm water sewers are involved. All polluters will be required to conform to this timetable and to the annual listing of actions required to achieve the surface water quality standards adopted.

Guides for Application of Standards

Water used for hydropower and commercial shipping depends mainly on quantity, depth and elevation; consequently, no specific quality standards for these uses have been prepared. The minimum standards apply to these as well as to waters for wildlife and stock watering supply, irrigation and waste assimilation.

Where two or more uses are designated in one water sector, the more exacting standard will apply. As an example, if the maximum permissible concentration of a substance in a water used for public supply is higher than allowable for fish and other aquatic life, and both of these uses are involved in one sector, then the allowable concentration cannot exceed that for fish and aquatic life.

Test procedures shall conform with "Standard Methods for the Examination of Water and Wastewater," 12th Edition, 1965, prepared and edited by the American Public Health Association, American Waterworks Association and Water Pollution Control Federation, or by other methods acceptable to the Department of Natural Resources and not contrary to the requirements of the Federal Government. The U. S. Atomic Energy Commission Rules and Regulations, Title 10, Part 20, Standards for Protection Against Radiation, will apply to the disposal and permissible concentrations of radioactive substances.

Water quality standards do not assure quantity and natural quality. Available water, when used in evaluating compliance with standards, will be based on the lowest average dilution for any period of 7 consecutive days in the most recent 10 years. In evaluating compliance, determinations of water quality will be made in accordance with procedures which will assure that the designated uses of such waters are fully protected. The Department may require management of waste admixture zones depending on such factors as effluent quality and quantity, available dilution, temperature, current and restrictions to the movement of fish.

Application of chemicals for water resource management purposes in accordance with statutory provisions is not subject to the requirements of the standards except in case of water used for public water supply.

The standards and water use designations are subject to revision as data become available that permit objectives to be stated by methods which define the variation or distribution of values in quantitative and statistically valid terms.

Categories of Standards

To preserve and enhance the quality of waters the following standards are established to govern water management decisions. It should be recognized that these standards will be revised as new information or advancing technology indicates that revisions are in the public interest.

1. Minimum Standards

Regardless of the water quality standards and water uses, untreated or inadequately treated wastes may not impair a designated use nor may standards be interpreted to permit a lower quality within a water sector than that now existing or required by outstanding orders. As a result of municipal, industrial, commercial, domestic, agricultural, land development or other activities, conditions may arise which will be controlled by the following standards:

a. Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to create a nuisance.

b. Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to create a nuisance.

c. Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to create a nuisance.

d. Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts, which by bio-assay and other appropriate tests, indicate acute or chronic levels harmful to animal, plant or aquatic life.

2. For Public Water Supply

The following standards are applicable where a surface water is classified for public water supply:

a. Bacteria: Coliform number not to exceed 5,000 per 100 ml. as a monthly arithmetic average value; nor exceed this value in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml. in more than 5 percent of the samples. Counts as Most Probable Number (MPN) or Membrane Filter Coliform Counts (MFCC).

b. Dissolved Solids: Not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time.

c. pH: A range from 6.0 to 9.0 is permitted except in waters naturally having a pH of less than 6.5 or higher than 8.5 where effluent discharges may not reduce the low value or increase the high value of the surface water's pH by more than 0.5 standard units.

d. The intake water supply will be such that by appropriate treatment and adequate safeguards it will meet the Public Health Service Drinking Water Standards, 1962.

e. Other: Concentrations of other constituents must not be hazardous to health.

3. For Fish and Other Aquatic Life

a. The following standards are applicable to surface waters where maintenance of fish reproduction is of primary importance in the public interest and natural conditions permit:

(1) Dissolved Oxygen: The dissolved oxygen content shall not be lowered to less than 80 percent of saturation nor to less than 5 mg/l at any time. There shall be no abrupt change from natural unpolluted background by more than 1 mg/l at any time.

(2) Temperature: Not to exceed 84° F. No change from natural unpolluted background by more than 5° F. at any time nor at a rate in excess of 2° F. per hour.

b. The following standards are applicable to surface waters where fishing is desirable in conjunction with other uses and natural conditions permit:

(1) Dissolved Oxygen: For a balanced warm water fishery the dissolved oxygen content should not be less than 5.0 mg/l during at least 16 hours of any 24-hour period, nor less than 4.0 mg/l at any time.

(2) Temperature: Not to exceed 89° F. for warm water fish. No abrupt change from background by more than 5° F. at any time. In addition, authorization must be obtained for proposed installations where the discharge of a thermal pollutant may increase the natural maximum temperature of a stream by more than 3° F.

c. Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life.

d. Streams classified by law as trout waters shall not be altered from natural background by effluents that affect the stream environment to such an extent that trout populations are adversely affected in any manner.

e. pH: A range from 6.0 to 9.0 is permitted except in waters naturally having a pH of less than 6.5 or higher than 8.5 where effluent discharges may not reduce the low value or increase the high value of the surface water's pH by more than 0.5 standard units.

4. For Recreational Use

A sanitary survey and/or evaluation to assure protection from fecal contamination is the chief criterion in determining the suitability of a surface water for recreational use. In addition, the following bacteriological guidelines are set forth:

a. A water is acceptable for whole body contact if it has an arithmetic average coliform count of 1,000 per 100 ml. or less and a maximum not exceeding 2,500 per 100 ml. during the recreation season.

b. A water is acceptable for partial body contact if it has an arithmetic average coliform count of 5,000 per 100 ml. or less and with no more than 1 of the last 5 samples exceeding 20,000 per 100 ml. during the recreation season.

c. The Membrane Filter Coliform Count (MFCC) is the preferred method for determining coliform density; provided, however, that where turbidity due to algae or other material does not permit testing of a sample volume sufficient to produce significant results, or where low coliform estimates may be caused by high numbers of non-coliforms or the presence of substances toxic to the procedure, the Most Probable Number (MPN) is to be used to determine coliform density. The average is based on the last five test results. A more definitive test for fecal pollution is the Membrane Filter Fecal Coliform Count (MFFCC). Tests by this method are acceptable where correlation relating the count to sanitary hazards has been demonstrated. Acceptable values based on MFFCC are not shown, but may be adopted in future revisions.

5. For Industrial and Cooling Water Use

The following standards are applicable to surface waters designated for industrial processes and cooling purposes:

a. Dissolved Oxygen: Not less that 2.0 mg/l as a daily average value nor less than 1.0 at any time.

b. Dissolved Solids: Not to exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time.

c. pH: A range from 6.0 to 9.0 is permitted except in waters naturally having a pH of less than 6.5 or higher than 8.5 where effluent discharges may not reduce the low value or increase the high value of the surface water's pH by more than 0.5 standard units.

d. Temperature: Not to exceed 89° F.

(*Adopted as Interstate Standards by the Resource Development Board on April 26, 1967, Published in the May, 1967 REGISTER and effective June 1, 1967. The Board at its June 14, 1968 meeting designated these standards as also applicable to Intrastate waters. Intrastate Water Quality Standards and designated use classifications were published in August, 1968 and became effective on September 1. 1968.)

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Francis H. Schraufnagel

Because of increased interest in Lake Superior the Department undertook a special survey of the lake in July 1968. A total of 90 sites, most of them in the lake within Wisconsin's boundary, were sampled. The "Report on the Water Quality Survey in Wisconsin Waters of Lake Superior Made During July 1968", dated October 23, 1968, points out the extremely high quality of these waters.

In recognition of the growing concern with over-fertilization of our watercourses, the Department of Natural Resources Board, at its April 1969 meeting, adopted a policy on phosphorus removal from effluents. As part of the policy, the Department may require any wastewater discharger to remove excess amounts of phosphorus where such discharges are causing, or may cause, overfertilization of surface waters. A copy of the policy statement is attached as Appendix C.

(Appendix C follows:)

APPENDIX C

Manual Code 3403.1

State of Wisconsin
Department of Natural Resources

SUBJECT: Policy on Phosphorus Removal From Effluent
(Adopted April 17, 1969)

PREAMBLE

Phosphorus is a key nutrient controlling fertility of natural waters. Small concentrations of phosphorus may stimulate the growth of blue-green algae and other organisms, making rivers and lakes unsuitable for recreation and increasing water purification costs. Where algae do not thrive, increased growth of floating and bottom-rooted weeds impedes stream flow and complicates other aspects of water management.

Sewage effluents often contribute large amounts of phosphorus to surface waters. Methods exist for substantial removal of phosphorus from sewage and industrial wastes.

POLICY

Prompt action to reverse the present over-fertilization of waters of Wisconsin and to enhance the quality of these waters for all useful purposes is essential.

It is the policy of the Natural Resources Board that:

1. The Department of Natural Resources may require any wastewater discharger--regardless of population, volume or type of waste discharged, or geographic location--to provide for removal of excess amounts of phosphorus where such discharges are causing, or may cause, over-fertilization of surface waters.

2. In conformance with recommendations of the Lake Michigan Enforcement Conference, the Department shall take the actions necessary to achieve an overall reduction of at least 80 percent of the phosphorus tributary to municipal and industrial waste treatment facilities located within the Lake Michigan drainage basin by December 31, 1972.

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NATURAL RESOURCES BOARD POLICY	Distribution:
Date May 2, 1969	All Supervisory Personnel

Francis H. Schraufnagel

It should be noted that the plan for implementing water quality standards requires disinfection of all municipal sewage treatment plant effluents.

Federal, State, and local officials participated in a study concerning erosion and sedimentation on the red clay soils of northwestern Wisconsin. A 1967 report by the Red Clay Interagency Committee, "Erosion and Sedimentation Control on the Red Clay Soils of Northwestern Wisconsin," pointed out problems, despite limited land use, in much of Wisconsin drainage area tributary to Lake Superior, and the limited land use from farming and very little industry or municipalities. Most of the erosion in this area is through a natural geological process because of the peculiar nature of the area. While we are attempting to control the runoff from poor land management practices, it should be pointed out that this is still a natural phenomenon and is only part of the major problem.

The April 1966 Lake Superior Drainage Basin Report, the 1967 Report on Red Clay Problems of Northwestern Wisconsin, and the 1968 Report on Water Quality in Wisconsin Waters of Lake Superior are included with the report presented to the conferees.

(The reports are as follo[illegible])

April 28, 1966

REPORT ON AN INVESTIGATION OF THE POLLUTION IN THE LAKE SUPERIOR DRAINAGE BASIN MADE DURING 1965 AND EARLY 1966

GENERAL INFORMATION

Drainage Basin: Lake Superior
Drainage Basin 28

Area Surveyed: Wisconsin Drainage
to Lake Superior

DRAINAGE AREA AND USES

The Lake Superior Drainage Basin stretches for about 100 miles across Wisconsin and extends inland from Lake Superior an average of about 30 miles. It includes all of the state's drainage north of the Continental Divide. The St. Louis River and Minnesota-Wisconsin boundary on the west, Lake Superior on the north, and the Montreal River at the Michigan-Wisconsin border on the east complete the area's enclosure. Included in this section are the northern half to two-thirds of Douglas, Bayfield, Ashland and Iron Counties - a total area of 3,174 square miles.

The southern part of the basin lies in the Northern Highland, but the major portion of the area is in the Lake Superior Lowland. The Penokee Range from near Mellen to Hurley has ridge elevations varying from about 1,500 to 1,800 feet above mean sea level. Mount Whittlesey, the highest point in the basin, has an elevation of 1,872 feet compared to Lake Superior's elevation of slightly over 600 feet. Many rapids and several falls are found in streams draining the area.

The St. Louis River enters the lake at Superior and is by far the largest stream in this section, but most of its 4,950 square mile drainage area lies in Minnesota. Nearly two-thirds of Montreal River's basin, or 180 of the 281 square miles of watershed, is in Wisconsin and the remainder is in Michigan. Bad River, with a drainage network comprising somewhat over 1,000 square miles is the largest basin in the section. Following is a tabulation showing the Wisconsin drainage, in square miles, to Lake Superior from the major streams of this part of the state:

Amnicon River	- 130
Bad River	- 1,016
1. Marengo River	- 206
a. Brunsweiler Cr.	- 65
2. Potato River	- 127
3. Tylers Fork	- 102
4. White River	- 375
Bois Brule River	- 185
Fish River	- 139
Flag River	- 71
Iron River	- 150
Middle River	- 50
Montreal River	- 180
1. W. Br. Montreal R.	- 82
Nemadji River	- 177
1. Black River	- 94
Poplar River	- 46
St. Louis River	- 77
Sioux River	- 96
Siskiwit River	- 31

The U. S. Geological Survey currently operates four gaging stations in the area and daily flow records at these sites are available for a period of several years. In addition, records are available from discontinued stations and the U.S.G.S. makes seasonal high and low water flow measurements at other points in the basin.

A station has been operated on the Bois Brule River at Brule since 1942. The station measures runoff from a 113 square mile area. Records for the past 22 years show that the discharge averaged 169 cubic feet per second (c.f.s.) and ranged between 67 and 1,520 c.f.s. This station exhibits an unusually "strong" dry weather flow. Duration tables indicate that 95 percent of the time the flow exceeds 106 c.f.s. which is equivalent to a runoff rate of 0.94 c.f.s. per square mile.

From 1914 to 1922 and since 1948 a gaging station has been operated on Bad River, about 8½ miles south of Odanah. For the 24 years of record the 611 square mile drainage area had an average runoff of 600 c.f.s. The minimum flow found was 49 c.f.s. and during the 1960 flood a peak discharge of 27,700 c.f.s. was indicated. This station has a 95 percent discharge of 98 c.f.s. Records are available for a station operated at Mellen for a 6-year period, 1949-54, below an area of 101 square miles. During this period the stream flow averaged 131 c.f.s., a minimum mean daily discharge of 8.2 c.f.s. was found and 95 percent of the time a flow of 12 c.f.s. was exceeded.

A gaging station is located about 5 miles south of Ashland on the downstream side of the White River power plant. The average discharge for the 16 years of record amounted to 295 c.f.s. and ranged between 3.1 c.f.s. and 6,270 c.f.s. A 95 percent discharge of 151 c.f.s. is indicated and for the 269 square mile drainage area corresponds to a runoff rate of 0.56 c.f.s. per square mile.

The Montreal River's flow is measured at a location about 3½ miles north of Saxon. This station includes drainage from a 262 square mile area and has been operated since 1938. Stream flows for the 26 years of record varied from 2 c.f.s. to 6,600 c.f.s. and averaged 323 c.f.s. There is some variation in flow because of power plant operations and the regulated discharge from the Gile reservoir. The 95 percent flow amounts to 42 c.f.s. which is equivalent to a runoff rate of 0.15 c.f.s. per square mile.

Two other stations were operated in the Montreal River basin. Stream flow records for 8 years, at a location near Hurley, showed that a flow of 5.7 c.f.s. was exceeded 95 percent of the time. Twelve years of flow measurements on the West Branch Montreal River at Gile indicate a 95 percent discharge of 5.4 c.f.s.

Stream flow records for the past water year were not available when this report was being prepared. However, since runoff is dependent on precipitation, we can obtain an idea of stream discharges during 1965 from a review of the weather data. Climatological information is available from the weather observation station operated at the Ashland Experimental Farm. The average annual precipitation at this station has amounted to 28.47 inches. Although 1963 was a dry year with the precipitation amounting to 20.42 inches, 1964 and 1965 totals were 4.18 and 3.74 inches respectively above average. These figures would indicate that stream flows in 1965 were about normal. A further review of the weather information shows that the average temperature for all of 1965 was somewhat lower than usual with higher than average monthly temperatures found only in May, October and December.

The City of Superior with somewhat over 33,000 inhabitants is by far the largest city in the basin. However, overall the area has a low population density and comparatively few municipalities. Following is a tabulation of the 1960 populations of incorporated areas in the basin that are served by public sewerage facilities:

Ashland	10,132	Montreal	1,361
Bayfield	969	Superior (City)	33,563
Hurley	2,763	Superior (Vil.)	374
Mellen	1,182	Washburn	1,896

All of the counties involved and virtually all of the communities had population decreases between 1940 and 1960, as shown by comparison of census information for these years. The overall decrease during the 20-year period amounted to about 13 percent. This compares with a 20-year population growth of about 26 percent for the state as a whole during the same period.

The area has and continues to be highly dependent on its natural resources. Several of the communities were initially lumbering and mining towns. Virgin timber stands have been virtually depleted but sustained lumbering, pulp logging and Christmas tree harvesting continue to be important contributors to the economy. A relatively large portion of the basin is in national, state, county and industrial forests. Mining from a practical standpoint has been discontinued, but with taconite deposits and ore pelletizing there is potential for a revival.

Lake Superior, the world's largest fresh-water body, is a prime asset of this section. Its waters have good physical, chemical and bacteriological characteristics and the quantity is essentially unlimited. The lake is a source of water supplies, supports commercial and sport fishing, is important for shipping and has scenic and recreational appeals. Lake Superior has a moderating influence on the climate. The average yearly growing season is about 30 days longer near the lake than it is in the southern part of the basin.

The Cities of Ashland, Hurley and Washburn obtain their public water supplies from surface waters. Superior's source is from shallow infiltration wells located on an offshore strip of land. Some industries, too, use a surface supply. There are no significant surface water withdrawals for irrigation.

Three of the area's state parks have been established near waterfalls. Some other sections of rapids and falls have been developed for the generation of hydro-electric power with five installations of this type being noted. The power dams on the Montreal River at Saxon Falls and Superior Falls with respective heads of 133 and 138 feet, are the highest in the state.

Farming is important in parts of the area. About a dozen milk plants, mostly cheese factories, are located here. There are some apple orchards and also berry growing is noted. The Superior area is the industrial center of northern Wisconsin but otherwise there are few big industrial plants.

The basin provides a variety of water centered recreational uses including fishing, boating, swimming, canoeing, hunting, sight-seeing, etc. The Brule River of Lake Superior is a renowned trout stream and justifiably so - record brown and rainbow trout have been caught in its waters. A number of motels, resorts, cabins and camping facilities are available to the tourist. Recreational uses are becoming of increasing importance to the area's economy. Inroads are being made toward further development along these lines and also with regard to winter sports.

The importance of protecting the area's surface water resources is being recognized. Within approximately the past 12 years the Cities of Ashland, Bayfield, Mellen, Montreal, Superior and Washburn, as well as the Village of Superior, provided sewage treatment facilities. No previous comprehensive area-wide survey of the Lake Superior Basin was made. However, surveys were made with respect to various pollution sources during the past 15 years and in 1961 the States of Minnesota and Wisconsin cooperated in conducting a survey of the St. Louis River and the area near its mouth in the vicinity of Duluth and Superior.

SOURCES OF POLLUTION AND SURVEY FINDINGS

Sources of surface water pollution within the Wisconsin section of the Lake Superior Drainage Basin are shown in Table 1 which is attached. The listing of pollution sources and tributary streams are tabulated in a systematic fashion starting with those discharging directly into Lake Superior beginning on the west side of the basin and following the lake in an easterly direction to the mouth of the Montreal River. The mileages given show shoreline distances expressed in miles from the latter stream if along the lake or as distances from the stream's mouth for other points of interest within the basin. Following coverage of the sources along Lake Superior, the tables and report considers those located on streams of the basin beginning on the western side of the drainage area. The main stem of the stream is taken from headwaters to mouth followed by consecutive tributaries starting again on the upstream end and proceeding towards the mouth. Each source of pollution is numbered in consecutive order and shown on an attached map of the basin. Analytical results detailing the characteristics of the wastes being discharged and the condition of the streams above and below are tabulated in Table 2. A description of each waste source follows:

Superior Fiber Products, Inc., recently completed and placed into operation a hardboard mill. Industrial waste waters are treated with alum and screened prior to lagooning. Wastes overflow from the small lagoon into Lake Superior. A single sample of the discharge on January 19, 1966 had a biochemical oxygen demand (B.O.D.) and suspended solids content of 2,330 and 620 mg/l respectively. Both values are relatively high. Sewage is currently discharged to the lake but it is proposed to divert the sanitary wastes to the municipal sewerage system.

The City of Superior has a primary sewage treatment plant which was placed in operation in 1958. Provision is made for disinfection of effluent. The sewer system is of the combined type which results in overloading of the treatment works as well as by-passing of raw sewage during periods of storm water runoff. A program should be established leading to complete separation of the storm and sanitary sewers as soon as possible.

Booth Fisheries Division--Consolidated Foods Corporation processes fish at Bayfield. Operations are seasonal and primarily during the fall herring run. Offal is collected for mink food or taken by the gulls and wash water wastes are discharged directly to the lake. A septic tank is provided for sewage disposal but it also overflows to the lake.

Sand Bay Fisheries operates out of the Bayfield area. It is understood that fish are cleaned out on the lake, and it is claimed that offal is disposed of to the land. No observations were made of their operations during the survey.

Bodin Fisheries, Bayfield, processes fish throughout the year but their peak season is in late fall. Wastes from cleaning fish and washing boxes are discharged to Lake Superior via a submerged outlet. Septic tank treated sewage overflows to the lake.

The City of Bayfield has a primary sewage treatment plant with provision for disinfection of effluent which was constructed in 1958. Monthly operating reports are not submitted to the State Board of Health. Excess clear water enters the sewer system at times, resulting in some by-passing and reduced treatment efficiency. During a 24-hour survey performed on September 27 and 28, 1965, it was determined that the B.O.D. removal was 16.2 percent. Further studies should be made to determine whether more satisfactory treatment generally occurs.

The Pureair Sanatorium, Bayfield, has a septic tank and seepage system which overflows to a drainage course leading to Lake Superior.

The City of Washburn has a primary sewage treatment plant which was constructed in 1958. Provision is made for disinfection of effluent. During a 24-hour survey performed on September 13 and 14, 1965, it was found that no B.O.D. removal occurred. Further studies should be made to determine whether more satisfactory treatment generally occurs. Excess clear water enters the sewer system at times resulting in by-passing and reduced treatment efficiency. Monthly operating reports are not submitted to the State Board of Health.

The City of Ashland has a primary sewage treatment plant with provision for disinfection of effluent. Storm and sanitary sewer systems are combined which results in overloading the treatment facilities at times and by-passing raw sewage to surface waters. A 24-hour survey performed on September 7 and 8, 1965 showed a B.O.D. removal of only 4.5 percent. Further studies should be made to determine whether more satisfactory removals usually occur.

Crepe and waxing papers are made at the Ashland Division--American Can Company. Water reuse is practiced and chemicals added to the waste waters for flocculation and improved clarification. Difficulties have been experienced with the clarifier and the disposal of its sludge. Last fall's tests showed relatively high fiber losses. It is understood that an additional clarifier is being constructed. About two years ago complaints were received regarding the loss of film plastic. Although steps have been taken to collect and burn the plastic, some still reaches the lake.

The Union Tank Car Company has a small operation at Superior where railway tank cars are cleaned, repaired and tested. Oil bearing wastes are treated in an A.P.I. separator. The latter appears to be providing an adequate level of treatment for the intermittent waste discharges. Sanitary sewage is discharged to a rock filled pit and overflows to a ditch. Consideration should be given to discharge of sewage to a municipal sanitary sewer if available or otherwise providing adequate on-site facilities.

The Village of Superior has a sewage stabilization pond which was constructed along with the sanitary sewer system in 1963.

Coal briquets are made at the Stott Briquet Company plant in Superior. A water spray is seasonally used to cool the freshly made hot briquets and results in an overflow of black waste waters carrying a high level of suspended solids. Sanitary sewage is discharged to the municipal sewerage system.

The Great Northern Railway cleans tank cars at Superior. Wash waters are discharged to an oil-water separator and overflow to two lagoons connected in series. Sanitary sewage is discharged to the city sewers. The three sets of samples of the lagooned wastes discharged to a drainage ditch indicated an acceptable B.O.D. level and a relatively low loss of oil.

Railroad cars are cleaned, serviced and maintained at the Soo Line Railway yards in Superior. It is understood that sanitary sewage and industrial wastes originating on the premises are discharged to the city sewerage system for treatment. Two sets of samples were obtained of the roundhouse and yard drainage and their B.O.D., coliform count and oil content were somewhat high. Further checks should be made to see if the problem can be pinpointed.

The Murphy Oil Company--Superior Refinery treats their industrial wastes in separators and lagoons prior to their discharge to a drainage course. The latter extends for about 1½ miles to Lake Superior and goes through a park area. Occasionally complaints have been received regarding water quality in the park. Because of the limited dilution, a consistently high degree of treatment is needed at all times. Sanitary wastes originating at the refinery are discharged to the municipal sewerage system.

Koppers Company, Inc.--Forest Products Division creosotes wood products at Superior. Liquid industrial wastes are discharged to a lagoon. No overflow was noted on the three occasions during the survey when the disposal facilities were inspected. Septic tanks and soil absorption are used for treatment of sanitary wastes.

The Great Northern Railroad repairs ore cars at a location in the Allouez section of Superior. There apparently is no longer an oil or other liquid industrial waste problem at this site. However, sewage is discharged to the old oil separator unit and thence overflows to Bluff Creek. Improved facilities for sanitary sewage should be provided.

The Douglas County Hospital and Sanatorium, P. O. address Wentworth, is served by a trickling filter type sewage treatment plant which was placed into operation in 1959. A 24-hour survey of the treatment plant was conducted on July 20 and 21, 1965. During the survey the treatment plant reduced the waste's B.O.D. by 64.6 percent which is somewhat less than expected for this type of facility. Our report recommendations of December 1965 included additional operating attention, some changes in operation, conducting of basic control tests and the submission of monthly reports.

The Middle River Sanatorium and Douglas County General Hospital at Hawthorne have a trickling filter type sewage treatment plant which was placed in operation in 1956. During a 24-hour survey performed on July 19 and 20, 1965, it was found that this plant removed 84.1 percent of the B.O.D. from the raw sewage. Routine laboratory determinations should be performed at this plant and the results submitted to the State Board of Health each month.

The community of Iron River has a septic tank for sewage treatment. A 24-hour survey performed on August 16 and 17, 1965 showed a negative B.O.D. removal by this facility and an average B.O.D. concentration of 109 mg/l in the effluent. Some storm water is connected to the sewer system. Additional treatment should be provided.

American cheese is made at Fuhrmann's South Shore Dairy located about three miles north of Iron River. Whey is hauled out and septic tank treated milk wastes are discharged to a drainage course about one-half mile from the Iron River. Samples of the ditch near the river on August 17 and September 28 had B.O.D. values of 15.6 and 31 mg/l.

No sewer system presently exists at the community of Port Wing. Plans have been submitted to the State Board of Health covering construction of a sewer system and sewage stabilization pond.

Evertt Fisheries, Inc., conducts operations at two sites in Port Wing. At one location, fish are cleaned during an 8 or 9 month period annually. Untreated wastes are discharged to a swampy area near "Bibon Lake" which is in reality more like a boggy area. At the other plant, cleaned fish are smoked and operations extend throughout most of the year. Waste waters are treated in a septic tank and discharge to a drainage course leading to the Flag River. Samples were taken on only one day and revealed little evidence of water pollution. However, single sets of samples are not necessarily conclusive and it may be desirable to have improved disposal facilities because of a potential nuisance or to generally improve sanitation about the plants. The Town of Port Wing is considering a stabilization pond for treatment of community sewage. However, their plans do not include the fish processing wastes. Perhaps this matter should be rechecked to determine if the proposed sewerage facilities can accommodate the industrial wastes or be redesigned to handle them.

Marten's Dairy manufactures American cheese in the unincorporated community of Cornucopia. Untreated wash waters are discharged to a marshy area which overflows to the Siskiwit River. Occasional complaints over a number of years have been received regarding these waste discharges. Hauling facilities for disposal of whey have been intermittently used. Regular hauling of all whey and wash waters should be instituted or other suitable disposal facilities provided.

E. I. du Pont de Nemours & Company manufactures trinitrotoluene, TNT, at Barksdale. Waste waters are discharged to a ridge and furrow irrigation system and overflow to Boyd Creek, about 1½ miles from Chequamegon Bay. The disposal facilities were placed into operation in 1959 following our recommendation. However, the treatment works did not accomplish the desired results and the discharge contains a high color intensity and nitrite content. Color in particular has been the reason for complaints regarding the appearance of the stream.

The Ondassagon School, Route 3, Ashland, has a septic tank from which effluent is discharged to a tributary of Whittlesey Creek.

American cheese is made at the Mountain Valley Cheese Factory, Route 3, Ashland. Untreated wastes are discharged to a drainage course that leads to the North Branch of Whittlesey Creek. Whey is hauled out at times for land disposal. Steps should be taken to reduce or eliminate pollution of the watercourse.

The Farmers Cheese Factory, Route 3, Mason, manufactures American cheese. Untreated liquid wastes, including whey, are discharged to a drainage course which terminates at Fish Creek about 0.9 of a mile from the factory. Three sets of samples on Fish Creek above and below the factory drainage course showed a reduction in the stream's dissolved oxygen and an increase in its B.O.D. Poor whey disposal practices probably constitute the major problem. Because of the small operation and distance to a stream, pollution would not ordinarily be anticipated.

American cheese is made at the Moquah Cheese Factory. Waste waters are discharged to a drainage course which after about one mile reaches Pine Creek. Samples of the wastes being discharged into the drainage course had B.O.D. values of 799, 530 and greater than 11,000 mg/l. The latter sample was obtained in mid-January of this year and a further sample near the junction with Pine Creek had a B.O.D. result of 758 mg/l. Apparently a whey discharge was involved. Ordinarily one would not expect wastes from this factory to have an effect on Pine Creek.

The Twin Ports Co-op Dairy Association operates a receiving station at Benoit where milk is received in cans and transferred by bulk truck to another plant for processing. The factory is about one-half mile from the South Fork Fish Creek and apparently little wastes reach the stream. Two samples in the drainage course near the creek had B.O.D. values of 4.3 and 11.4 mg/l which is similar to normal runoff. The limited sampling indicates no problem under the survey conditions.

The Andersonville Co-op Dairy Association, Route 1, Ashland, manufactures American cheese. Wastes, including whey, are discharged to a drainage course which merges into a tributary and after about five miles joins Beartrap Creek. The U.S.G.S. maps show the watercourse as an intermittent stream for about two miles east of the factory. On two occasions, evidence of strong wastes was noted in the drainage course about one mile east of the plant. This, too, appears to be a borderline pollution problem and the discharge of whey is not helping matters.

Penokee Veneer conducts operations at Mellen. Boiler blow-down and some soaking tanks overflow to the Bad River. B.O.D. values of 3.8, 15.5 and 4.8 mg/l were found on the three occasions when sampled. Based on these values and the small flow involved, it does not appear that these wastes are objectionable.

The City of Mellen has a primary sewage treatment plant which was constructed in 1963. Provision is made for disinfection of effluent. Excess clear water enters the sewer system at times. Monthly reports are not submitted to the State Board of Health.

St. Mary's Indian School at Odanah has a septic tank for sewage treatment prior to discharging to the Bad River.

The Radloff Cheese Factory, Highbridge, manufactured cheese at a location on a drainage course about two miles from the Marengo River. Operations were discontinued at this factory early this year.

American cheese is manufactured at the Marengo Co-op Dairy Association factory. Whey is hauled out for disposal and wash waters discharge to a drainage course. The latter, after about two-thirds of a mile, terminates at the Brunsweiler River, a short distance from its confluence with the Marengo River. The four samples of wastes discharged to the drainage course had B.O.D. concentrations ranging from about 1,000 to 6,000 mg/l. It is understood that consideration is being given to construction of a ridge and furrow system.

The community of Iron Belt has a septic tank for sewage treatment. A 24-hour survey on August 9 and 10, 1965 at this facility showed a B.O.D. removal of 22 percent. It appears that excess clear water enters the sewer system at times. Additional treatment should be provided.

The community of Saxon has a sewer system which receives sanitary sewage and storm water from portions of the community. The system discharges to a swamp which drains to Vaughn Creek.

Mason Milk Products operates a cheese factory in the Village of Mason. Untreated waste waters and septic tank treated sewage is discharged to the White River. Whey is hauled out for land disposal at times. Two sets of samples were obtained. The June samples showed stream increases in B.O.D. from 0.8 mg/l immediately above the outfall to 8.6 mg/l at a point about 0.8 of a mile below, and these were associated with coliform results of 12,000 and 150,000 per 100 ml. at the respective stations. Adequate waste treatment facilities should be provided.

A primary sewage treatment plant is provided by the City of Hurley. Monthly operating reports are not submitted to the State Board of Health and no records are available on disinfection of effluent or laboratory determinations made by operating personnel. Excess clear water enters the sewer system at times. During a 24-hour survey performed on September 20 and 21, 1965, it was found that the B.O.D. concentration of the raw sewage averaged 55.4 mg/1 and the B.O.D removal was only 11.5 percent.

The Ruppe Cement Products Company crushes rock and washes sand and gravel at a location about 10 miles south of Hurley. Waste waters containing fine sand and silt are discharged to a lagoon. No waste water overflows were noted during the survey.

The City of Montreal has a primary sewage treatment plant with pre-aeration and disinfection of effluent. During a 24-hour survey on July 26 and 27, 1965, it was found that the B.O.D. removal was 37.5 percent. Excess clear water enters the sewer system at times. Monthly reports are not submitted to the State Board of Health.

The community of Pence provides for sewage treatment with a septic tank. A 24-hour composite sample of the effluent collected on August 3 and 4, 1965 had a B.O.D. of 138 mg/1. Additional treatment should be provided.

CHEMICAL

The data pertinent to the condition of the watercourse concerned is tabulated in Table 2 attached. The analytical information presented follows the same system of organization as employed for Table 1. Results obtained for a single source of waste are grouped following the name of such source. Mileage figures for the sampling stations and pollution sources located along Lake Superior are in shoreline miles from the Montreal River mouth. Inland points are measured from the respective stream mouth.

Samples were collected by representatives of the Committee on Water Pollution and State Board of Health at the stations shown. Determinations were made of temperature, pH and dissolved oxygen (D.O.) at the time of sample collection. Determination of biochemical oxygen demand (B.O.D.), solids, bacteriological concentrations and other specified tests were made by the State Laboratory of Hygiene. Definitions of terms used are appended to this report.

BIOLOGICAL

A biological stream survey is a study of stream conditions as they affect the growth and production of biological life within a stream. Whereas chemical determinations revealed current pollutional loadings, biological analysis indicated a long-term effect of those loadings as they are assimilated into the production of living matter. Biological evaluations may be broken into several aspects including phytoplanktonic organisms, zooplanktonic organisms, vertebrate organisms (fish), and invertebrate organisms. The invertebrate organisms lend themselves best to this type of study in that they are relatively immobile and consequently are directly subjected to the pollutional loadings imposed upon the habitat. Under these conditions, an organism must respond to a particular contaminant by a physiological adaptation or die.

There exists within biological communities all gradations and variations of adaptability toward adverse conditions that may be imposed upon the bio-habitat. Some species cannot tolerate any appreciable pollution whereas others are not only tolerant but appear to thrive under relatively foul conditions. Species intolerant of pollution respond to contamination by reduction in numbers or by complete disappearance from the habitat. Tolerant forms respond according to the severity of pollution. When competition is reduced by the elimination of more competitive forms, the population of more tolerant forms may increase. On the other hand, as the severity of pollution becomes more intense, the tolerant organisms will be reduced or eliminated from the community and only organisms with special adaptations can survive.

Pollution normally expresses itself on the bio-habitat and aquatic organisms in one of two ways. It may be toxic to the organism, and in this situation the substance will usually affect all organisms uniformly. Under such conditions, one does not observe a specific group becoming more or less predominant. The general tendency is rather that all the macro-invertebrates disappear at relatively the same time. This type of ecological situation is noted with wastes containing such items as heavy metals, tars or oils, chlorinated hydrocarbons and a host of others.

Pollution may also express itself in a subsequent change in the bio-environment which favors certain types of organisms and is detrimental to other organisms. This is the situation observed in organic types of pollution such as paper mill wastes, milk plant wastes, sewage treatment plant wastes, etc. Organic wastes need dissolved oxygen to reach a more stable chemical state. The oxygen dissolved in water varies between 7 and 14 parts per million depending on the temperature (air contains about 200,000 parts per million).

Aquatic organisms must derive their oxygen from the water and consequently when an organic waste is undergoing stabilization it competes with the macro-invertebrate fauna for the very limited oxygen present. Since the biochemical stabilization process will continue until all oxygen has been utilized or the compounds are stabilized, the organisms requiring various oxygen tension levels are deprived of this necessary material. If stabilization occurs very quickly, a good deal of the oxygen is left in the water and natural reaeration will tend to replace that which was lost. However, if stabilization of the organic compounds continues, the dissolved oxygen in the water is reduced to critical levels for organisms that are not adapted for the most efficient utilization of dissolved oxygen. Some aquatic organisms are not only efficient in extracting the last iota of dissolved oxygen out of the water but can resort to deriving oxygen from the air above the water. These organisms are not only favored by low dissolved oxygen levels and the subsequent absence of efficient competitors, but the waste of organic material can also be utilized as food for these organisms and consequently their numbers usually increase.

Another bio-habitat effect of a waste may be to cover the bottom habitat and this is often observed in silt and paper mill wood waste. Again, this will normally favor a particular group of organisms and by quantitatively sampling these bio-environments, a biologist can evaluate a source of pollution on the stream ecology.

It must be pointed out that different stream characteristics give rise to different communities regardless of the presence or absence of pollution. Thus, sampling to determine pollutional effects must be made at carefully selected sites and each sampling site must be evaluated as to its particular physical effect on the bio-habitat. In general, riffle areas reveal populations most indicative of the degree of pollution and consequently specific effort is made to sample in these areas.

The physical collection of the biological samples for the Lake Superior Basin survey was made with one of three devices capable of sampling a known unit area of bottom; thus, all samples are considered quantitative except those where a qualitative sample is specified. The sampling devices utilized were a Petersen dredge, sampling .8 of a square foot, used in gravel, sand and small stone habitats; the Surber square foot sampler used in rocky and boulder habitats; and the Eckman dredge, with a $\frac{1}{4}$-square foot sampling area used in sludge, silt and mud. Samples were washed several times and screened through a U. S. Standard 35-mesh screen which retained the bottom organisms and a minimum of debris for preservation and storage. Organisms were separated from debris and were identified and enumerated at the laboratory. All identifications were made to the most specific level possible, but due to taxonomic uncertainties of certain groups, all identifications must be considered tentative. However, these uncertainties in identification are not likely to affect the evaluation of the species in terms of pollutional tolerance.

RESULTS OF BIOLOGICAL INVESTIGATION

The Lake Superior Drainage Basin biological field work was conducted on September 1 and 2, 1965. The biological survey includes 29 sampling stations which are summarized in Table A. The results of biological sampling showed the following sources of waste to have had little or no recent effect on the benthic community of the receiving streams:

Village of Superior Sewage Treatment Plant	- Superior
Middle River Sanitorium and Douglas County General Hospital	- Middle River
Iron River Sewage Treatment Plant	- Iron River
Fuhrmann's South Shore Dairy	- Iron River
Mountain Valley Cheese Factory	- R. 3, Ashland
Moquah Cheese Factory	- Moquah
Twin Ports Co-op Dairy Association	- Benoit
Penokee Veneer Company	- Mellen
Mellen Sewage Treatment Plant	- Mellen
Mason Milk Products	- Mason
Montreal Sewage Treatment Plant	- Montreal
Pence Sewage Treatment Plant	- Pence

Newton Creek

One quantitative sample, No. 23-B, was collected from Newton Creek, one mile below the Murphy Oil Corporation. The sample revealed an unbalanced benthic population with no intolerant species represented. The population of organisms was low with only 32 tolerant and very tolerant organisms present per square foot. A polluted water condition was further suggested by the presence of slime growths, oil slicks and a distinct oily odor.

Bear Creek

Two quantitative samples were taken from Bear Creek in the vicinity of the Douglas County Hospital and Sanitorium. Sample No. 21-A was collected above the institution and revealed a typical clean water benthic population with four intolerant species represented. The relatively unsuitable clay bottom prevented the development of a more extensive benthic community. Sample No. 21-B was more representative of an unbalanced benthic community with only one intolerant species and one intolerant organism observed in the square foot sample. The fewer intolerant organisms and the increase of very tolerant organisms below the outfall suggests an excessive organic loading on the stream, resulting in periodic low dissolved oxygen concentrations.

Siskiwit River

Two quantitative samples were collected from the Siskiwit River in the vicinity of Marten's Dairy, Cornucopia. Sample No. 17-A, collected 300 feet above the dairy, revealed a typical clean water benthic population. Sample No. 17-B, collected below the dairy, contained no intolerant species. The entire physical habitat of the river had changed from a fast aerated stream to a relatively deep, slow stream. Under these conditions, any waste discharges have a more pronounced influence since reaeration is substantially reduced. It appears that periodic waste discharges are reducing the dissolved oxygen in the river but that the discharges are not consistent such that a polluted water benthic community cannot be established.

One quantitative sample, No. 24-B, was collected below the E. I. du Pont de Nemours & Company plant at Barksdale. The sample revealed nearly sterile conditions with only one intolerant species present. Population densities were low and amounted to only 10 organisms per square foot. A bio-assay was conducted with the stream water to determine its toxicity. A 25 percent solution (250,000 p.p.m. stream water) resulted in the complete mortality of blunt-nose minnows in approximately five hours. No mortality was noted in a 10 percent (100,000 p.p.m.) dilution in 48 hours. However, there appeared to be internal bleeding in several of the fish which was not observed at lower concentrations. The reduced benthic population appears to be due to toxic materials rather than low dissolved oxygen concentrations.

Iron Belt Tributary

Quantitative samples were taken 0.3 mile above the Iron Belt sewage treatment plant and 0.1 mile below. Sample No. 5-A, above, revealed normal clean water conditions with four intolerant species observed.

Sample No. 5-B, collected below the outfall, revealed an unbalanced benthic community. Intolerant organisms were reduced to three in number. The reduced intolerant organisms suggest periodic low dissolved oxygen levels caused by excessive organic loading.

Montreal River

Two quantitative samples were collected from the Montreal River in the vicinity of Hurley. Sample No. 2-A, collected above the Hurley sewage treatment plant, was representative of a clean water environment. Sample No. 2-B, collected approximately 0.5 mile below the outfall, revealed semi-polluted conditions with no intolerant organisms present. The substantial increase in the number of very tolerant organisms is indicative of continuous enrichment and the absence of intolerant organisms suggests low dissolved oxygen concentrations are developed due to organic waste loading.

DISCUSSION

The discharge of fermentable organic wastes to a confined surface water results in the development of a degree of pollution dependent primarily on the oxygen requirements of such wastes and the amount of dissolved oxygen available in the receiving waters. Where the organic loading, expressed as biochemical oxygen demand, exceeds the self-purification capacity of the stream, critical and zero dissolved oxygen concentrations develop at downstream locations. This condition creates an environment unsuitable for fish and other clean water forms of aquatic life, renders water unfit for general recreational purposes and undesirable for stock watering. Under high loadings the water may have a dark appearance, be septic and give off offensive odors. The zone of decomposition extending below any sewer discharging such wastes exhibits characteristic chemical-physical-biological phenomena which may be measured by analyses of stream water and biological samples taken above and below such sources of waste.

Biochemical oxygen demand is a measure of the amount of oxygen utilized by fermentable organic matter in undergoing decomposition. For a given section of stream the biochemical oxygen demand--dissolved oxygen relationship is controlled by temperature, time, reaeration and concentration. When the temperature of a water is increased, its ability to hold oxygen is decreased. With increased stream temperature, decomposition proceeds at a more rapid rate and the point of low dissolved oxygen will be found nearer the point of discharge. Conversely, with cold water temperatures the rate of decomposition is slowed up and the zone of low dissolved oxygen is farther downstream from the pollution source. For a given biochemical oxygen demand loading and open stream waters, with temperatures just above the freezing point, critical oxygen conditions are less likely to occur because of the higher initial dissolved oxygen and improved reaeration capacity. With ice cover, much of a stream's reaeration ability may be lost and critical conditions can develop at a substantial distance from the pollution source.

While untreated and insufficiently treated sanitary sewage possesses the same dissolved oxygen consuming properties as organic industrial waste, such sewage also contains bacteria of intestinal origin which may create a public health hazard for persons coming in contact with waters receiving such waste.

The discharge of an undesirable level of settleable and suspended solids may cause the formation of sludge and sediment deposits on the stream bed, interfering with the development of normal biological life of the stream. Furthermore, particulate matter frequently causes turbidity and color to the surface water making it objectionable. Soluble organic solids promote slime growths which attach themselves to the stream bottom and vegetation. Slime growths create an unsightly condition and interfere with the habitat of fish food organisms.

CONCLUSIONS

The Lake Superior Drainage Basin of Wisconsin has a comparatively low population density and relatively little industry. In general, surface waters of the basin are in good condition. Within approximately the past 12 years all of the sewered municipalities of the basin provided basic sewage treatment facilities. However, localized problems were found near some industries and communities. The economy of the area is highly dependent on clean waters. Further steps should be taken where indicated to protect the surface water resources of the basin.

Respectfully submitted,

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JM

Table 1
Lake Superior - Drainage Basin 28
1965-1966

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream Per Day	
					Gallons	#5-Day B.O.D.
	Lake Superior					
	St. Louis River	148.3				
1	Superior Fiber Products, Inc.	147.3	Paper	Chemical & Screening	440,000	8,400
2	Superior, City of	146.0	Sewage	Primary	3,600,000	4,000
	a. Northern Brewing Co.					
	b. Russell Crmy. Co. of Wis.					
	c. Twin Ports Co-op Dairy Association					
	Soo Line Drainage					
	Newton Creek	144.5				
	Nemadji River	143.7				
	Bluff Creek	142.8				
	Bear Creek	141.8				
	Middle River	134.1				
	Iron River	116.6				
	Flag River	110.0				
	Siskiwit River	88.2				
3	Booth Fisheries Division - Consolidated Foods Corp.	55.3	Fish Processing	None	?	?
4	Sand Bay Fisheries	55.2	" "	"	?	?
5	Bodin Fisheries	54.8	" "	"	?	?
6	Bayfield, City of	54.5	Sewage	Primary	120,000	130
7	Pureair Sanatorium	52.5	Sewage	Septic Tank		
8	Washburn, City of	41.0	Sewage	Primary	180,000	235
	Boyd Creek	37.5				
	Whittlesey Creek	35.2				
	Fish Creek	34.3				
9	Ashland, City of	31.4	Sewage	Primary	1,400,000	1,050
10	American Can Co. - Ashland Div.	29.3	Paper	Chemical & Settling	2,400,000	2,000
	Kakagon River	23.6				
	Bad River	13.1				
	Montreal River	0.0				
	St. Louis River					
	Pokegama River	5.0				
11	Union Tank Car Co.	1.0	Oil	Separator	?	?
	Great Northern Drainage	0.2				
	Lake Superior (U. S. 53)	0.0				
	Pokegama River					
12	Superior, Village of	5.8	Sewage	Lagoon	37,000	10
	St. Louis River	0.0				

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream Per Day Gallons	 #5-Day B.O.D.
	Great Northern Drainage					
13	Stott Briquet Co	1.0	Coal	None	?	?
14	Great Northern R.R. Co.	0.9	Oil	Separator	?	?
	St. Louis River	0.0				
	Soo Line Drainage					
15	Soo Line R.R. Co.	1.2	Oil etc.	None	?	?
	Lake Superior	0.0				
	Newton Creek					
16	Murphy Oil Corporation - Superior Refinery	1.6	Oil	Separators & Lagoons	150,000	?
	Lake Superior	0.0				
	Nemadji River					
	Crawford Creek	5.2				
	Lake Superior	0.0				
	Crawford Creek					
17	Koppers Co.	0.9	Chemical	Lagoon		
	Nemadji River	0.0				
	Bluff Creek					
18	Great Northern R.R., Allouez	3.5	Oil?	Separator	?	?
	Lake Superior	0.0				
	Bear Creek					
19	Douglas Co. Hospital & Sanatorium	3.2	Sewage	Secondary	40,000	16
	Lake Superior	0.0				
	Middle River					
20	Middle River Sanatorium & Douglas Co. Gen. Hospital	14.5	Sewage	Secondary	16,000	9
	Lake Superior	0.0				
	Iron River					
21	Iron River, Unincorporated - Town of Iron River	16.6	Sewage	Primery	40,000	70
22	Fuhrmann's South Shore Dairy	13.6A	Milk	Septic Tank	3,000	24

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream Per Day Gallons	#5-Day B.O.D.
	Flag River					
23	Evertt Fisheries, Inc.	1.2	Fish Processing	None	?	?
	Lake Superior	0.0				
	Siskiwit River					
24	Marten's Dairy	0.2	Milk	None	2,700	27
	Lake Superior	0.0				
	Boyd Creek					
25	E. I. du Pont de Nemours & Co.	1.5	Chemical	Irrigation	220,000	
	Lake Superior	0.0				
	Whittlesey Creek					
	N. Branch Whittlesey Creek	0.1				
	Whittlesey Creek	0.0				
	North Branch Whittlesey Creek					
26	Ondassagon School	1.3	Sewage	Septic Tank	15,000	15
27	Mountain Valley Ch. Fcty.	1.2	Milk	None	3,000	30
	Whittlesey Creek	0.0				
	Fish Creek					
	Ditch	15.2				
	Pine Creek	6.6				
	S. Fork Fish Creek	1.3				
	Lake Superior	0.0				
	Ditch					
28	Farmers Cheese Factory	0.9	Milk	Milk	1,000	10
	Fish Creek	0.0				
	Pine Creek					
	Moquah Cheese Factory Tributary	1.9				
	Fish Creek	0.0				
	Moquah Cheese Factory Tributary					
29	Moquah Cheese Factory	0.9	Milk	None	3,000	30
	Pine Creek	0.0				
	South Fork Fish Creek					
30	Twin Ports Dairy - Benoit	9.4	Milk	None	?	?
	Fish Creek	0.0				

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream Per Day	
					Gallons	#5-Day B.O.D.
	Kakagon River					
	Beartrap Creek	4.5				
	Lake Superior	0.0				
	Beartrap Creek					
	Little Beartrap Creek	8.2				
	Kakagon River	0.0				
	Little Beartrap Creek					
31	Andersonville Co-op Dairy Association	4.5	Milk	None	?	?
	Beartrap Creek	0.0				
	Bad River					
32	Penokee Veneer Co.	41.1	Wood	None		
33	Mellen, City of	39.3	Sewage	Primary	60,000	60
	Marengo River	24.9				
	Potato River	23.0				
	White River	4.2				
	Lake Superior	0.0				
	Marengo River					
	Brunsweiler River	4.9				
34	Radloff Cheese Company	4.3A	Milk	(Discontinued Operations)		
	Bad River	0.0				
	Brunsweiler River					
35	Marengo Co-op Dairy Assoc.	0.5	Milk	None	3,000	30
	Marengo River	0.0				
	Potato River					
	Alder Creek	19.6				
	Vaughn Creek	1.5				
	Bad River	0.0				
	Alder Creek					
	Iron Belt Tributary	4.6				
	Potato River	0.0				
	Iron Belt Tributary					
36	Iron Belt, Uninc., Town of Knight	0.5	Sewage	Primary	30,000	53
	Alder Creek	0.0				

					Est. Discharge to Stream Per Day	
No.	Source or Stream	Miles	Type of Waste	Treatment	Gallons	#5-Day B.O.D.
	Vaughn Creek					
37	Saxon, Town of	13.0	Sewage	Primary	20,000	30
	Potato River	0.0				
	White River					
38	Mason Milk Products	26.3	Milk	None	2,250	22
	Bad River	0.0				
	Montreal River					
	Laymans Creek	33.2				
39	Hurley Sewage Treatment Plant	22.4	Sewage	Primary	250,000	310
	West Fork Montreal River	15.1				
	Lake Superior	0.0				
	Laymans Creek					
40	Ruppe Cement Company	3.9	Silt	Lagoon		
	Montreal River	0.0				
	West Fork Montreal River					
	Pence Tributary	8.8				
41	Montreal, Village of	6.1	Sewage	Primary	130,000	150
	Montreal River	0.0				
	Pence Tributary					
42	Pence, Town of	1.4	Sewage	Primary	40,000	45
	Gile Flowage	0.0				

Table 2
Lake Superior - Drainage Basin 28
1965-1966

No.	Waste Source	Miles	Sample Source	Date	BOD mg/l	Temp. °C.	pH	DO mg/l	MFCC per 100 ml.
				Lake Superior					
1	Superior Fiber Products, Inc.	147.3	Lagoon Outfall	1-19-66	2,330	-	4.7	-	-
					(S.S. = 620, Lignin = 400)				
2	Superior, City of	146.0	STP Outfall	7-7-65	147	17	7.6	0.0	32,000,000
				7-14-65	141	16	7.1	0.1	30,000,000
				8-24-65*	130	-	6.95	-	-
3	Booth Fisheries Div. - Cons. Foods Corporation	55.3		11-2-65		(Inspection)			
				2-2-66		(Inspection)			
4	Sand Bay Fisheries	55.2		11-2-65		(Inspection)			
				2-2-66		(Inspection)			
5	Bodin Fisheries	54.4		11-2-65		(Inspection)			
				2-2-66		(Inspection)			
6	Bayfield, City of	54.5	STP Outfall	9-27-65*	119	-	-	-	-
				9-28-65	69.6	13½	7.1	4.0	10,000
				11-2-65	147	9	7.3	0.0	53,000,000
7	Pureair San.	52.5	STP Outfall	9-28-65	249	16	6.4	1.1	32,000,000
				11-2-65	190	6½	6.8	1.5	65,000,000
8	Washburn, City of	41.0	STP Outfall	9-13-65*	149	-	-	-	-
				11-2-65	165	12	7.2	1.5	47,000,000
				12-7-65	129	6	7.1	-	47,000,000
9	Ashland, City of	31.4	STP Outfall	6-24-65	92	15	7.2	2.2	400,000
				8-11-65	37	18	7.2	4.2	10,000
				9-7-65*	160	-	-	-	-
				9-29-65	70.2	14	7.3	4.1	< 100
10	Ashland Div., American Can Co.	29.3	Clarifier Outlet	10-11/17-65	146		10.1	-	-
						(S.S. = 464)			
				St. Louis River					
11	Union Tank Car Company	1.0	Seperator Outfall	7-8-65		(No Overflow)			
				11-4-65		(No Overflow)			
				1-19-66		(No Overflow)			
				Pokegama River					
12	Superior, Village of	5.8	Lagoon Outfall	3-23-65*	72	-	7.4	-	500,000
				7-14-65	21.5	20	9.5	13.7	<1,000

No.	Waste Source	Miles	Sample Source	Date	BOD mg/l	Temp. °C.	pH	DO mg/l	MPCC per 100 ml.
			Great Northern Drainage Course						
13	Stott Briquet Company	1.0	Waste Waters	11-4-65	7.1	-	7.0		(S.S. = 2,281)
				1-19-66	4.2	-	6.8		(S.S. = 460)
14	Great Northern Railroad	0.9	Separator Outfall	7-7-65	8.0	-	-	-	-
				11-4-65	8.6	-	8.1	-	(Oil = 7.0)
				1-19-66	9.5	-	9.5	-	1,000 (Oil = 3.0)
			Soo Line Drainage						
15	Soo Line R.R. Company	1.2	Outfall	7-14-65	67.8	16	7.5	5.3	3,500,000
				11-4-65	31.6	-	7.4	-	(Oil = 24)
			Newton Creek						
16	Murphy Oil Corp., Superior Refinery	1.6	Lagoon Overflow	7-14-65	33.9	23	7.7	5.3	2,000
				11-4-65	12.5	-	6.9	-	(Oil = 24) (Phenol = 0.019)
		0.3	Third St., Below	7-14-65	7.6	20	7.3	1.1	3,000
				11-4-65	6.6	-	6.9	-	(Oil = 3) (Phenol = 0.019)
				1-19-66	44.8	(Oil = 2.2, Phenol = <.1)			
			Crawford Creek						
17	Koppers Co., Incorporated	0.9	Lagoon Outfall	1-20-65		(No Overflow)			
				7-23-65		(No Overflow)			
				2-6-66		(No Overflow)			
			Bluff Creek						
		4.6	CTH "Z"	2-3-66	2.3	0	7.0	7.2	<100
18	Great Northern R.R., Allouez	3.5	Outfall	2-3-66	57.3	4	8.1	8.2	30,000 (Oil = 523)
				3-16-66	< 3.0	-	7.3	-	80,000
		0.4	USH 2	2-3-66	< 1.0	0	6.9	-	180
			Bear Creek						
		3.3	CTH "Z" Above	7-20-65	1.7	14	7.5	8.4	14,000
				1-19-66	1.3	0	7.35	11.1	900
19	Douglas Co. Hosp. & San.	3.2	STP Outfall	7-20-65	48.7	18	7.7	5.3	20,000
				7-20-65*	47.6	-	7.8	-	-
				1-19-66	34.6	3	7.35	3.7	45,000,000
		2.1	Tn. Rd. Below	7-20-65	2.9	14	7.5	8.0	400,000
				1-19-66	2.6	0	7.9	8.0	1,000

No.	Waste Source	Miles	Sample Source	Date	BOD mg/1	Temp. °C.	pH	DO mg/1	MFCC per 100 ml.
			Middle River						
		14.5+	50 Feet Above	7-19-65	1.6	18	7.3	8.0	1,900
				1-19-66	2.7	0	6.7	11.8	11,000
20	Middle River San. & Douglas Co. Gen. Hosp.	14.5	STP Outfall	7-19-65	93.7	18	7.3	3.9	<10,000
				1-19-66	77.2	4	7.25	0.4	9,000,000
		14.2	Town Road Below	7-19-65	3.9	18	7.3	7.7	44,000
				1-19-66	5.3	0	7.15	11.8	>89,000
			Iron River						
		16.6	Town Road Above	8-17-65	1.9	23	8.1	7.8	1,000
				9-28-65	1.5	9	7.4	10.2	900
21	Iron River, Unincorporated-Tn. of Iron River	16.6-	STP Outfall	8-16-65*	109	-	7.2	-	-
				8-17-65	112	22	7.3	4.6	96,000,000
				9-28-65	131	13	7.4	4.7	48,000,000
		15.1	Town Line Rd. Extended	8-17-65	0	23	7.9	7.5	60,000
				9-28-65	2.3	9	7.4	10.4	34,000
		13.9	CTH "B"	8-17-65	1.0	23	7.7	7.5	56,000
				9-28-65	1.2	8	7.4	10.6	78,000
22	Fuhrmann's S. Shore Dairy	13.6A	Outfall Ditch	8-17-65	15.6	19	7.3	6.6	>200,000
				9-28-65	31	7	7.2	9.4	18,000
		12.7	Town Road Below	8-17-65	1.4	23	7.7	8.4	810,000
				9-28-65	3.3	8	7.4	11.7	19,000
			Port Wing Samples						
			Adjacent to Town Road	2-2-66	<.5	0	7.3	13.0	200
								(Chlorides = 2.0)	
23	Evertt Fisheries, Incorporated		Swamp 1	2-2-66	<.5	0	7.3	6.1	<100
								(Chlorides = 0.0)	
			Swamp 2	2-2-66	<.5	0	7.9	13.0	100
								(Chlorides = 0.0)	
			STH 13	2-2-66	<.5	0	7.1	12,7	100
								(Chlorides = 3.5)	
			Siskiwit River						
		0.7	Town Road Above	8-17-65	1.6	16	7.9	9.8	1,000
				9-28-65	1.5	8	7.3	11.9	300
24	Marten's Dairy	0.2	Outfall	8-17-65	332	17	7.3	5.6	200,000,000
				9-28-65	<300	14	7.1	5.5	1,900,000

No.	Waste Source	Miles	Sample Source	Date	BOD mg/1	Temp. °C.	pH	DO mg/1	MFCC per 100 ml.
		0.1	STH 13	8-17-65	3.1	17½	7.3	8.3	3,000
				9-28-65	1.8	7	7.4	11.3	200
			Boyd Creek						
25	E. I. du Pont de Nemours & Co.	2.2	Town Road Above	7-21-65	-	21	-	-	500
									(Nitrites =<.03)
				11-2-65	-	5	7.1	-	300
									(Nitrites = .014)
				2-2-66	<.5	0	6.9	5.7	-
		1.5	Red Water	7-21-65	-	38	7.15	-	<1,000
									(Nitrites = 160)
				11-2-65	-	33	7.5	-	-
									(Nitrites = 245)
				2-2-66	-	-	8.6	-	-
									(Nitrites = 290)
		1.5	Wash Water	7-21-65	-	32	7.7	-	<1,000
									(Nitrites = 0.36)
				11-2-65	-	19	6.8	-	-
									(Nitrites = 0.168)
				2-2-66	-	16	7.6	-	-
									(Nitrites = 1.32)
		0.2	STH 13	7-21-65	-	20	7.5	-	14,000
									(Nitrites = 44.5)
				11-2-65	-	8	7.4	-	1,700
									(Nitrites = 45)
				2-2-66	-	0	8.0	-	-
									(Nitrites = 64)
			North Branch Whittlesey Creek						
		2.2	Town Road Above	6-24-65			(No Flow)		
				8-11-65			(No Flow)		
				9-28-65			(No Flow)		
				11-2-65			(No Flow)		
26	Ondassagon School	1.4	Outfall	6-24-65	1.0	16	7.3	6.5	110,000
				8-11-65	10.9	17	7.4	-	11,500,000
				9-28-65	371	15	8.2	4.5	62,000,000
				11-2-65	20	13	7.3	6.9	5,600,000
27	Mountain Valley Cheese Factory	1.4	Outfall	6-24-65	20.6	20	8.5	7.6	12,000,000
				8-11-65	125	26	9.5	-	60,000
				9-28-65	43.1	31	7.9	5.6	9,600,000
				11-2-65	34.7	19	7.0	7.5	460,000
		1.1	Town Road Below	6-24-65	1.6	11	7.5	9.1	6,000
				8-11-65	1.7	14	7.6	9.1	60,000
				9-28-65	4.3	8½	7.6	9.0	120,000
				11-2-65	1.3	8	7.5	9.9	48,000

No.	Waste Source	Miles	Sample Source	Date	BOD mg/1	Temp. °C.	pH	DO mg/1	MFCC per 100 ml.
Fish Creek									
		15.4	CTH "E" Above	11-2-65	<.5	7	7.1	12.3	900
				12-7-65	1.1	0	6.3	10.2	40,000
				2-2-66	0.6	0	6.9	11.2	500
	Cheese Factory Ditch	15.2	To Stream						
		15.0	Town Road	11-2-65	13	8	6.1	8.1	500
			Below	12-7-65	3	0	6.1	7.0	1,000
				2-2-66	1.4	0	7.0	10.8	1,500
Ditch									
28	Farmers Cheese Factory	0.9	Outfall at	11-2-65	>5,750	14	4.0	0.0	<10,000
			Plant	12-7-65	700	-	-	-	20,000
		0.2	Outfall	11-2-65	126	13	5.9	0.0	<10,000
			Ditch at	12-7-65	7.6	1	6.4	1.3	2,000
			CTH "E"	3-16-66	8.8	2	6.7	6.5	1,000
Pine Creek									
		2.6	Town Road	8-11-65			(No Flow)		
			Above Cheese	9-29-65			(No Flow)		
			Fcty. Trib.						
		1.9	50 Feet Above Fcty. Trib.	1-18-66	1.3	3	7.4	12.8	600
		0.1	Town Road	8-11-65	1.3	13½	7.3	10.3	800
			Below	9-29-65	0	7½	7.4	11.2	500
				1-18-66	2.3	2½	7.4	13.0	<100
Moquah Cheese Factory Tributary									
29	Moquah Cheese Factory	0.9	Outfall	8-11-65	799	30	6.5	-	140,000,000
				9-29-65	530	16	7.0	-	510,000
				1-18-66	>11,000	16	5.6	0.0	1,600,000
		0.0	Tributary Mouth	1-18-66	758	0	6.2	3.0	<10,000
South Fork Fish Creek									
		9.5	CTH "F"	8-11-65	1.6	19	7.2	6.4	3,200
			Above	9-29-65	6.6	7	7.2	9.4	900
30	Twin Ports Coop. Dairy	9.4	Outfall	8-11-65	4.3	16	7.8	8.7	700,000
			Ditch	9-29-65	11.4	11	8.8	9.2	19,000
		8.0	Adjacent to	8-11-65	1.7	21	7.3	8.4	4,000
			CTH "F" Below	9-29-65	1.8	7½	7.2	10.2	500

No.	Waste Source	Miles	Sample Source	Date	BOD mg/l	Temp. °C.	pH	DO mg/l	MFCC per 100 ml.
			Little Beartrap Creek						
31	Andersonville Co-op Dairy Association	4.5	Outfall	12-7-65	66	5	6.6	-	730,000
		3.5	Town Road Below	12-7-65	>87.8	0	6.2	2.3	160,000
				1-18-66	808	0	4.4	0.0	<10,000
		0.2	Town Road Below	1-18-66	1.4	0	7.0	8.2	<100
		0.2		3-16-66	7.4	2	6.9	11.1	<10,000
			Bad River						
		41.1+	100 Feet Above	6-23-65	0.7	21	7.5	8.8	120,000
				8-10-65	1.4	18	7.1	7.3	800
				10-28-65	2.3	4	7.3	11.1	27,000
32	Penokee Veneer Co.	41.1	Outfall	6-23-65	3.8	52	7.9	4.6	120,000
				8-10-65	15.5	34	7.3	3.0	10,000
				10-28-65	4.8	48	7.5	16.4	32,000
		39.8	STH 13	6-23-65			No Sample		
				8-10-65	1.4	18	7.1	6.9	2,500
				10-28-65	1.1	4	7.3	11.9	20,000
		39.3	Town Line Road	6-23-65	0.6	21	7.5	9.0	110,000
				8-10-65	0.9	18	7.0	7.0	1,600
				10-28-65	0.8	4	7.3	11.1	25,000
33	Mellen, City of	38.8	STP Outfall	6-23-65	92	17	7.2	2.7	75,000,000
				8-10-65	56.9	16	7.1	4.9	306,000,000
				10-28-65	178	12	7.3	2.4	34,000,000
		38.3	STH 169	6-23-65	1.1	21	7.5	9.3	120,000
				8-10-65	0.9	18	7.0	6.0	6,000
				10-28-65	1.7	4	7.3	10.5	51,000
		3.6	Hwy. 2 at Odanah	1-6-65	1.1	0	7.1	11.7	300
				2-2-65	2.3	0	7.2	12.0	100
				3-2-65	2.6	1½	7.1	11.4	<100
				4-7-65	2.1	1½	7.2	12.7	200
				5-4-65	1.4	14	7.2	9.1	800
				6-15-65	0.4	19	7.2	8.2	500
				7-13-65	2.3	24	7.2	7.6	10,000
				8-4-65	0.7	20	7.4	7.3	700
				9-8-65	<.5	15½	7.4	8.3	-
				10-5-65	1.2	7½	7.3	10.0	500
				11-3-65	0.6	7½	7.4	11.3	400
				12-2-65	0.7	½	7.1	13.3	500
				1-5-66	1.4	0	7.0	13.0	300
				2-1-66	1.3	1	7.1	10.9	100
				3-10-66	0.6	1½	7.0	11.8	100

No.	Waste Source	Miles	Sample Source	Date	BOD mg/1	Temp. °C.	pH	DO mg/1	MFCC per 100 ml.
			Marengo River						
		8.9	STH 13 at Marengo	11-2-65	1.1	8	6.8	11.1	27,000
				2-1-66	1.6	0	7.1	10.5	200
		4.9	Brunsweiler R.						
34	Radloff Cheese Company	4.3A	Outfall Ditch to River	9-29-65	43	9½	7.0	3.2	290,000
				11-2-65	6.8	9	7.3	4.0	13,000
		3.4	Town Road Below	11-2-65	1.6	9	7.3	11.5	15,000
				2-1-66	0.9	0	7.1	10.5	200
			Brunsweiler River						
		2.9	STH 13	11-2-65	1.1	9	7.3	11.0	66,000
35	Marengo Co-op Dairy Assoc.	1.0	Outfall	8-11-65	1,080	22	6.2	-	29,000,000
				9-29-65	1,050	9½	6.2	0.8	700,000
				11-2-65	3,440	11	4.2	0.0	390,000
				2-1-66	6,370	1	4.7	0.0	1,900,000
			Alder Creek						
	Iron Belt Tributary	4.6							
		3.1	Town Road Below	8-10-65	0.9	17	7.3	6.5	3,000
			Iron Belt Tributary						
		0.7	Above at Fence Line	8-9-65	<.5	15	7.5	8.5	700
				10-28-65	<.5	1½	7.5	12.9	100
36	Iron Belt, Uninc. Tn. of Knight	0.5	STP Outfall	8-10-65	42.9	13	7.0	3.1	20,000,000
				8-10-65*	59	-	-	-	-
				10-28-65	39.6	7	7.3	5.3	6,900,000
		0.2	Trail Below	8-9-65	1.8	15	7.1	3.3	130,000
				10-28-65	1.1	3	7.3	9.7	95,000
			Town Road Below	8-10-65	0.9	17	7.3	6.5	3,000
			Vaughn Creek						
			STH 128	8-10-65	No Sample				
				10-28-65	0.5	4	7.1	6.6	<10,000
				12-7-65	0.9	0	7.1	6.9	51,000
37	Saxon, Town of		STP Outfall	8-10-65	65.9	15½	7.6	2.6	65,000,000
				10-28-65	168	9	7.7	3.4	2,600,000
				12-7-65	51.4	6	7.7	-	12,000,000

No.	Waste Source	Miles	Sample Source	Date	BOD mg/1	Temp. °C.	pH	DO mg/1	MFCC per 100 ml.
			Town Road Below	8-10-65	2.2	16	7.2	1.8	29,000
				10-28-65	2.4	4	7.0	3.0	9,000
				12-7-65	0.6	0	6.8	3.5	6,000
			White River						
		26.3+	Above 50 Ft.	6-24-65	0.8	20	7.5	8.3	12,000
				9-29-65	2.0	8	7.4	10.4	2,500
38	Mason Milk Products	26.3	Outfall	6-24-65	2,070	21	6.4	0.0	300,000,000
				9-29-65	45	16½	7.4	6.6	200,000
		25.5	STH 63	6-24-65	8.6	20	7.5	8.4	150,000
				9-29-65	1.7	7½	7.5	10.6	2,400
			Beartrap Creek						
		8.2+	Above Little Beartrap Cr.	1-18-66	1.3	0	7.0	10.2	100
		8.2	Little Beartrap Creek						
		5.0	CTH "A" Below	1-18-66	3.3	0	7.0	10.2	<100
		23.4	Poplar St.	7-27-65	3.1	20	6.75	7.3	6,500
				8-10-65	1.1	19½	7.2	7.4	31,000
				10-28-65	2.0	4	7.1	11.5	41,000
39	Hurley, City of	22.4	STP Outfall	7-27-65	69.5	17	7.2	4.4	57,000,000
				8-10-65	108	16½	7.3	5.1	220,000,000
				9-20-65*	49	-	-	-	-
				10-28-65	140	10	7.7	1.2	58,000,000
		21.8	USH 2	7-27-65	1.9	19	7.4	1.7	190,000
				8-10-65	0.9	18	7.2	6.1	32,000
				10-28-65	2.4	4	7.3	10.7	720,000
		0.9	Hwy. 122 Bridge	1-6-65	1.6	0	7.1	13.6	400
				2-2-65	1.5	0	7.1	13.5	800
				3-2-65	1.7	1	7.1	11.5	1,700
				4-7-65	2.5	2	7.2	13.3	2,500
				5-4-65	2.6	15	7.1	9.8	60,000
				6-15-65	1.1	20	8.2	10.2	400
				7-13-65	2.0	25	7.2	7.9	37,000
				8-4-65	1.4	20½	7.2	7.8	3,000
				9-8-65	<.5	15	7.1	9.6	10,000
				10-5-65	0.8	7	7.4	11.1	1,300
				11-3-65	0.5	8	7.5	12.2	50,000
				12-2-65	1.7	½	7.1	13.4	1,800
				1-4-66	2.4	½	7.0	13.6	2,100
				2-1-66	2.0	½	7.1	12.8	1,600
				3-10-66	0.9	1	6.9	12.1	4,200

No.	Waste Source	Miles	Sample Source	Date	BOD mg/1	Temp. °C.	pH	DO mg/1	MFCC per 100 ml.
			Laymans Creek						
40	Ruppe Cement Company	6.1	Lagoon Outfall			No Discharge			
			West Fork Montreal River						
		8.8	Pence Trib.						
		7.0	Tn. Rd. Below Pence Trib.	10-28-65	1.4	3	6.9	9.9	800
				11-7-65	<.5	0	7.1	10.3	800
		6.2	STH 77	7-27-65	1.1	23	7.2	7.6	39,000
				8-10-65	3.1	21	6.9	7.9	2,000
				10-28-65	1.2	6	7.1	11.2	1,200
41	Montreal, City of	6.1	Outfall	7-27-65	35.3	17	7.2	0.4	49,000,000
				8-10-65	58.2	17	7.2	2.1	150,000,000
				10-28-65	63.5	8	7.2	0.3	32,000,000
		6.0	R.R. Bridge	7-27-65	1.6	23	7.3	7.6	700,000
				8-10-65	3.1	21½	7.0	7.5	2,500,000
				10-28-65	3.4	6	7.1	11.5	1,200
		5.0	Town Road Below	10-28-65	1.4	6	7.1	11.9	48,000
			Pence Tributary						
42	Pence, Town of		Outfall	10-28-65	82.5	9	7.0	3.5	27,000,000
				11-7-65	128	6	6.7	-	51,000,000

*Composite Sample

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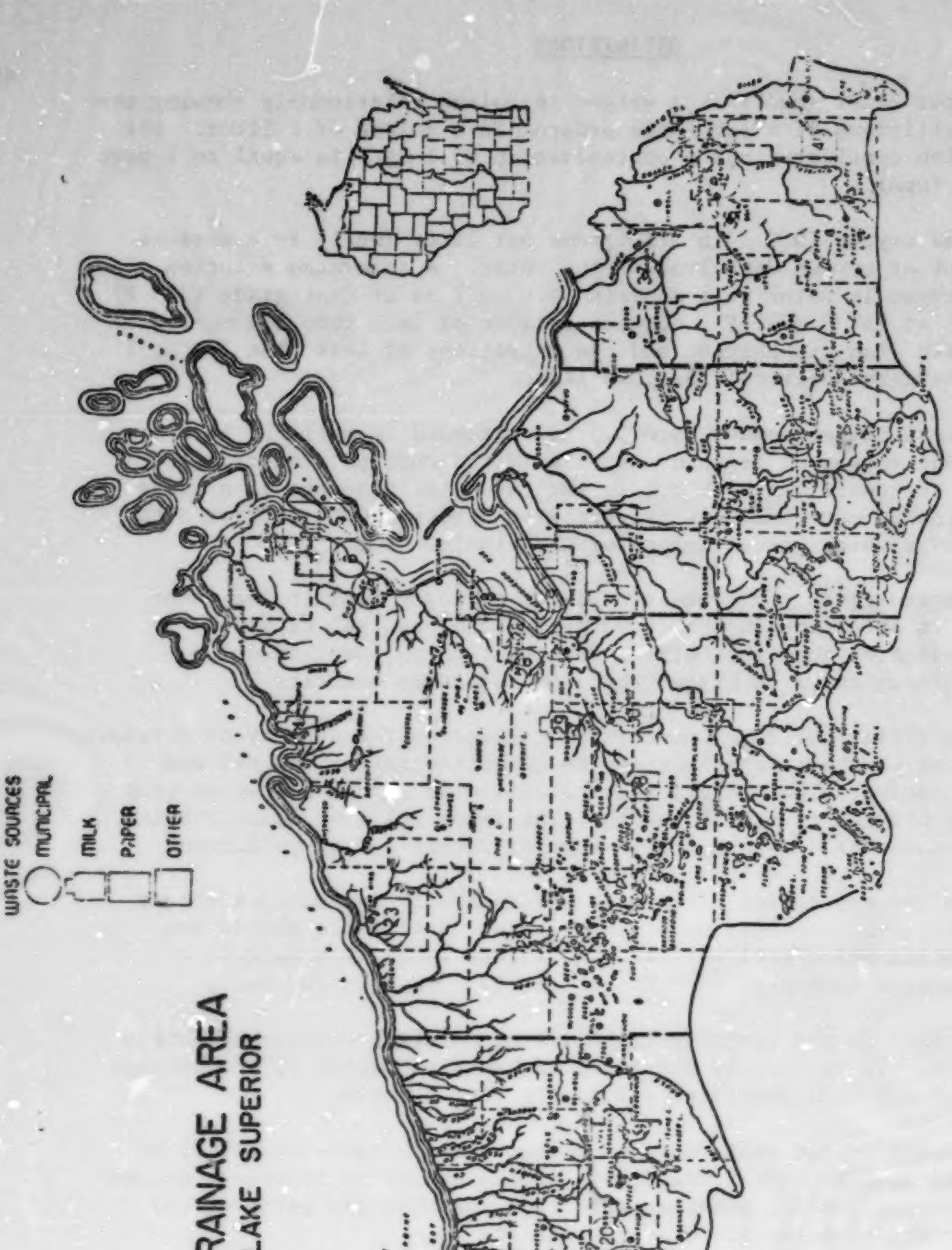
Table 6

Lake Superior - S. W. 28

Biological Station Summary - 1965

Sample No.	Date	River	River Mileage	Sample Area	Source of Waste	Station Location	Bottom	Current	Organisms Per Square Foot						Remarks
									Intolerant		Tolerant		V. Tol.		
									Gen.	No.	Gen.	No.	Gen.	No.	
23-A	9-2	Pokegama	6.1	Superior	None Known	0.3 mi. above outfall	Rock, Gravel & Clay	Riffle	10	113	4	298	2	4	
23-B	9-2	Pokegama	5.8-	Superior	Village of Superior Lagoon	Town road below outfall	Rock & Clay	Riffle	7	101	3	99	1	99	Poor site
[illegible]	9-2	Newton Creek	0.6	Superior	Murphy Oil	1.0 mi. below Murphy Oil	Rock & Gravel	Riffle	-	-	2	38	1	14	Slime growths, oil slick and oily odor noted
21-A	9-2	Bear Creek	3.2+	Wentworth	None Known	Town road above outfall	Rock & Clay	Riffle	4	24	2	10	-	-	Poor site
21-B	9-2	Bear Creek	2.2	Wentworth	Douglas County Hospital & Sanitorium	1 mi. below outfall	Rock, Gravel & Clay	Riffle	1	1	1	2	1	51	Poor site
20-A	9-2	Middle	14.9+	Hawthorne	None Known	150 ft. above outfall	Rock & Gravel	Riffle	13	46	4	32	2	4	
20-B	9-2	Middle	14.0	Hawthorne	Middle River Sanitorium and Douglas County General Hospital	0.5 mi. below outfall	Rock & Gravel	Riffle	9	393	4	133	1	25	
19-A	9-1	Iron	16.6+	Iron River	None Known	Town road above outfall	Rock, Gravel & Sand	Riffle	7	273	4	137	2	4	
19-B 19-A	9-1	Iron	15.6	Iron River	Iron River S.T.P.	1.0 mi. below Iron River S.T.P. 2.0 mi. above Fuhrmann's South Shore Dairy	Rock & Gravel	Riffle	6	93	6	39	2	2	
19-C	9-1	Iron	12.6	Iron River	Fuhrmann's South Shore Dairy	1.0 mi. below outfall	Rock & Gravel	Riffle	12	599	5	93	-	-	
18-A	9-1	Siskiwit	0.3+	Cornucopia	None Known	300 ft. above dairy	Rock & Gravel	Riffle	7	282	7	199	1	10	
18-B	9-1	Siskiwit	0.2-	Cornucopia	Morton's Dairy	Highway 13 Bridge	Rock & Sand	Slow	-	-	2	152	2	27	
[illegible]	9-1	Fish Creek	1.9-	Ashland	E. I. du Pont de Nemours & Co.	Highway 13 Bridge	Rock & Gravel	Riffle	1	1	1	8	1	1	[illegible]
[illegible]	9-1	North Br. Whittlesey Creek	0.9	Ashland	Mountain Valley Cheese Factory	0.3 mi. below outfall	Sandy Loam	Moderate	2	11	4	254	1	19	[illegible]
[illegible]	9-1	Tributary to Pine Creek	0.9-	Moquah	Moquah Cheese Factory	1st town road bridge below outfall			7	80	4	90	-	-	
[illegible]	9-1	South Fork Fish Creek	9.6+	Benoit	None Known	At County Trunk "F"	Rock	None	3	40	2	23	1	14	
[illegible]	9-1	South Fork Fish Creek	9.9	Benoit	Twin Ports Dairy	1.5 mi. below dairy	Rock	None	3	28	1	10	1	2	
8-A	9-1	Bad	41.2+	Mellen	None Known	100 ft. above hot water outfall	Rock	Fast	9	40	2	12	1	1	
8-B	9-1	Bad	41.1-	Mellen	Penokee Veneer Company	Below outfall and above Mellen S.T.P.	Rock	Fast	7	31	2	12	2	3	
[illegible]	9-1	Bad	39.0	Mellen	Mellen S.T.P.	0.3 mi. below S.T.P.	Rock & Gravel	Fast	10	131	5	41	1	2	
[illegible]	9-1	Iron Belt Tributary	[illegible]	Iron Belt	None Known	0.3 mi. above outfall	Rock & Gravel	Riffle	4	10	4	12	-	-	
[illegible]	9-1	Iron Belt Tributary	[illegible]	Iron Belt	Iron Belt S.T.P.	0.1 mi. below outfall	Rock & Gravel	Riffle	1	3	5	54	1	51	
[illegible]	9-1	White	25.3+	Mason	None Known	100 ft. above outfall	Rock & Sand	Fast	10	111	5	46	1	5	
[illegible]	9-1	White	[illegible]	Mason	Mason Milk Products	0.5 mi. below outfall	Rock & Gravel	Riffle	10	126	3	18	1	1	Foam on water at outfall
[illegible]	9-1	Montreal	[illegible]	Hurley	None Known	Above Hurley S.T.P.	Rock & Sand	Riffle	7	27	1	16	2	51	
[illegible]	9-2	Montreal	[illegible]	Hurley	Hurley S.T.P.	0.5 mi. below outfall	Gravel & Sand	Moderate	-	-	4	130	3	444	
[illegible]	9-1	West Fork Montreal	[illegible]	Montreal	None Known	Highway 77 above Montreal S.T.P.	Rock & Gravel	Riffle	6	174	3	9	2	8	Sewage noted
[illegible]	9-1	West Fork Montreal	[illegible]	Montreal	Montreal S.T.P.	1.0 mi. below Montreal	Rock & Gravel	Riffle	10	16	2	10	2	2	Sewage noted
[illegible]	9-1	Pence Tributary	[illegible]	Pence	Pence S.T.P.	1.3 mi. below Pence	Rock	Riffle	4	107	2	13	3	19	


DRAINAGE AREA
LAKE SUPERIOR
WASTE SOURCES
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DEFINITIONS

Milligrams per liter (mg/l) is a weight to volume relationship showing the amount in milligrams of a substance present in a volume of 1 liter. For most pollution considerations a concentration of 1 mg/l is equal to 1 part per million (ppm).

The dissolved oxygen (D.O.) in milligrams per liter (mg/l) is a measure of the amount of oxygen dissolved in the water. A saturated solution of dissolved oxygen in water will contain 14.6 mg/l at 0° Centigrade (32° F) and 8.4 mg/l at 25° C (77° F). Concentrations of less than 5.0 mg/l D.O. interfere with fish propagation and concentrations of less than 3.0 mg/l D.O. are considered critical for fish life.

The biochemical oxygen demand (B.O.D.) is expressed in mg/l and is a measure of the amount of organic matter oxidized through biochemical processes. In general, a high B.O.D. indicates the presence of a large amount of organic material. It is normal to find a B.O.D. of from 2 to 3 mg/l in river waters receiving natural drainage.

The pH value indicates the concentration of hydrogen ions in the water and is used to determine whether a water is acid, neutral or basic. A pH of 7.0 indicates that the water is neutral. A pH lower than 7.0 indicates acidity and a pH higher than 7.0 indicates basicity.

The membrane filter coliform count (MFCC) indicates the density of coliform organisms. Since these organisms may be of intestinal origin and are numerous in sewage, high numbers are indicative of sewage pollution with its possible hazards to public health. The fecal coliform count (MFFCC) is sometimes used as a more specific test of recent sewage pollution.

Suspended solids are solids mixed with and generally imparting a cloudy appearance to water, sewage, or other liquids. Settleable solids are suspended solids which will settle in quiescent water or sewage in a reasonable period commonly, though arbitrarily, taken as two hours.

Pollutional load is the quantity of polluting material discharged into a body of water. It is usually expressed in terms of pounds of biochemical oxygen demand per day, pounds of solids per day, or both.

Toxic wastes are wastes containing ingredients which cause mortality of fish or other aquatic life irrespective of the amount of dissolved oxygen present. Ammonia, acids, alkalies, cyanides, phenols and salts of the heavy metals are examples of toxic substances.

Biota is a term for all the living forms in a stream ranging from bacteria through microscopic plants and animals and insect larva, to higher forms such as fish and rooted plants.

Plankton are microscopic drifting organisms found in natural waters. The plant forms are known as phytoplankton whereas the animal forms are called zooplankton.

Aerobic organisms are organisms which require free (elementary) oxygen for their growth. Anaerobic organisms will grow in the absence of free oxygen and derive oxygen by breaking down compounds containing oxygen combined with other substances. Facultative organisms are organisms which can adapt themselves to growth in the presence, as well as in the absence, of dissolved oxygen.

EROSION
AND
SEDIMENTATION
CONTROL

ON THE RED CLAY SOILS OF NORTHWESTERN WISCONSIN

Red Clay Interagency Committee

1967

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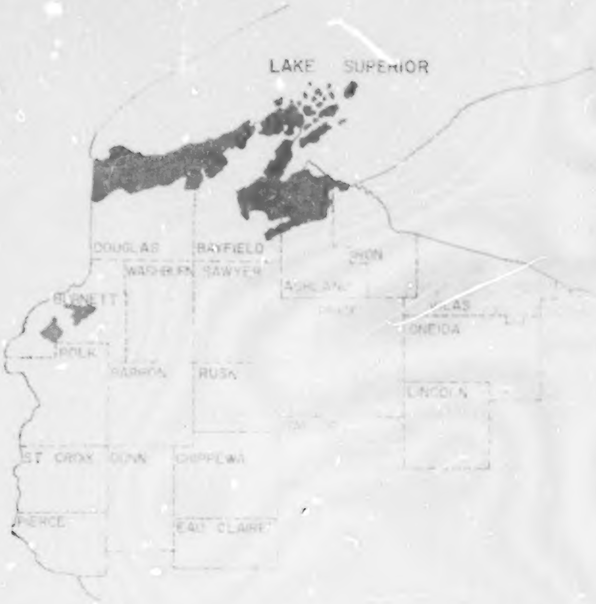


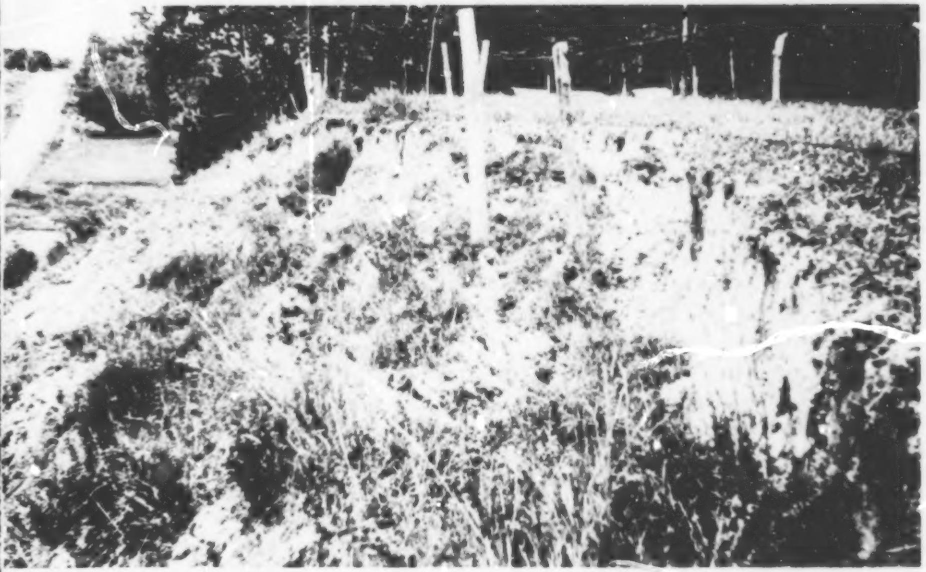
Areas of Red Clay Soils in Northwestern Wisconsin

PREFACE

In 1955 representatives of state and federal agencies concerned with land-use problems on the red clay soils of northwestern Wisconsin met to determine the cause of extreme sedimentation in lakes and streams. From 1958 to the present time this committee evaluated land-use problems especially in the Whittlesey Watershed, applied available techniques, and conducted studies for the control of erosion and sedimentation. The activities included ways and means of stabilizing the toe of stream banks and the establishment of protective cover on stream and highway banks and in ditches to protect them against loss of topsoil and eventual stream and lake siltation.

This report is a digest of these studies and was prepared as a guide to town, county and state highway officials, individual landowners, educational organizations, sportsmen, and conservation and other civic organizations concerned with the control of erosion and resulting sedimentation. It consists of sections on Problems and Recommendations, and an Appendix containing a summary of Development and Research. The sections on Problems and Recommendations are based on the studies listed and briefly described in the Appendix.

The committee feels strongly that if the recommendations contained in this report are carefully followed and implemented on the land, soil erosion and sedimentation of streams and lakes can be greatly reduced. Such a program is mandatory for the protection of Wisconsin's natural resources including the achievement of desirable water quality standards. While the report deals specifically with land-use problems on the red clay soils of northwest Wisconsin, many of the principles and practices also apply to other soil types.



▲ Road bank slippage from erosion not only fills road ditches with sediment, but also cuts into fields and sometimes leaves fences hanging.

◀ Whittlesey Creek — once a trout stream, now a dry sedimented stream bed.

THE GENERAL PROBLEM

Sedimentation in streams and rivers of the Lake Superior drainage, resulting in part from excessive erosion, has been classified by the committee as the number one problem in the northwestern red clay area of Wisconsin. This area contains 880,000 acres of land located in Ashland, Bayfield, Douglas and Iron Counties. Due to the relatively steep slopes in the watersheds in this area, unprotected red clay soils are unstable and therefore highly erodible, particularly along field gullies, roads and stream banks.

The red clay area is geologically young with soil erosion processes still occurring naturally at a rapid rate. These become accelerated wherever and whenever steep slopes become bare due to natural or man-made causes. The levels of sedimentation in the streams can be classified as: "accelerated" following catastrophic floods, and "continuing" occurring in the normal flow. Abnormally heavy rains have periodically accelerated erosion on exposed clay soils. Man has also speeded up erosion through certain agricultural activities, timber cutting and highway construction.

Erosion was speeded up as the area was first cleared — clear-cutting of forest land, clearing of agricultural fields and to some extent fires were the major contributing factors. Conditions in the area have been steadily aggravated through destructive logging practices, improper construction and inadequate maintenance of roads, intensive grazing along the stream banks and ravines which exposes bare soils, and improper drainage to the point that now even minor precipitation is accompanied by a great deal of soil loss.

Although erosion and the resultant sedimentation cannot be eliminated entirely, they can be reduced through proper soil and water conservation practices. Generally, the presence of vegetation on steep slopes is one of the principal soil stabilizing factors. To the extent that forest cover prevents, deters, or postpones erosion, forests are valuable. However, forest cover alone is not the answer to adequate erosion control. Deep gullies were formed in bygone days before axe or saw even touched a tree on these red clay soils. However, vegetation serves to reduce runoff both by its use of water in growth processes and by physical retardation. While cover alone will not in many cases stabilize the steep raw slopes, the maintenance of existing cover and the restoration of cover on denuded areas are among the first courses of action.

SPECIFIC PROBLEMS

Agriculture

With the possible exception of the era when extensive land clearing was carried out, agricultural practices have not been a major cause of sedimentation. Only a relatively small part of the red clay area is in agriculture. For example, in the 6,134-acre Whittlesey Watershed, only 1,060 acres (37 farms) are in crop land. Most of these farms are engaged in dairying. Generally all of the farms in the Whittlesey Watershed are following a good conservation crop rotation.

The major detrimental practice is the grazing of cattle in woodlands, on stream banks and along ravines. Field waterways have been improved but more work should be done on them and continuous maintenance practiced. Also field drainage must be carefully controlled to minimize sediment runoff into streams and road ditches.

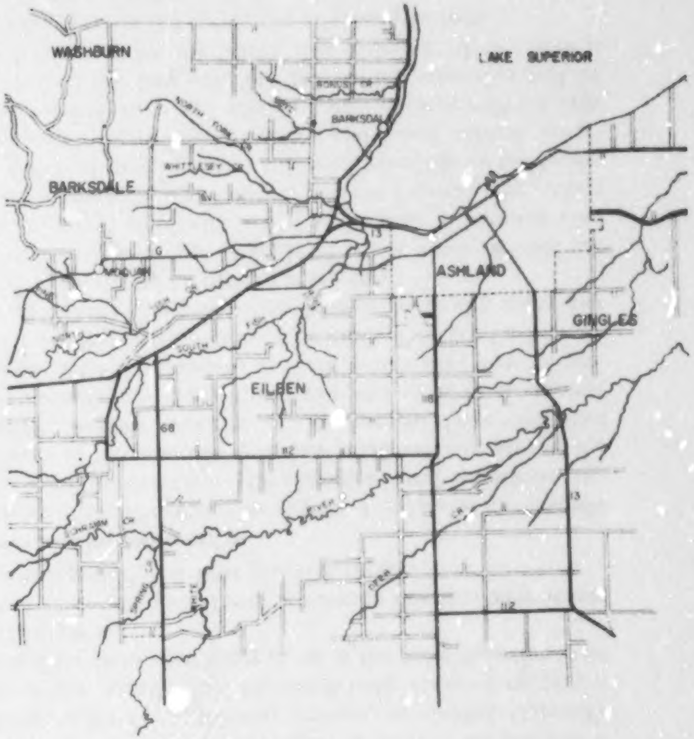
Highways

Highway construction was a major source of sedimentation in the past particularly before the severity of the problem was recognized. Some improvement in sedimentation control has been achieved, but considerably more is urgently needed, especially along county and town roads.

Highway officials, as well as the users of the road, are chiefly concerned with the establishment and maintenance of an all-weather roadway. The trunk system of roads divert and concentrate the water from its natural drainage pattern and hence in many cases greatly increase the erosion and flooding problems in the area.

The warped surface of the red clay area, associated with steep irregular valley slopes that are frequently dissected by natural drainage ways, and the deep gorge of the mainstream are formidable obstacles to a well-stabilized roadbed. The road ditches collect water from the slope and discharge it at steep grades into the natural ravines. The deepening of the roadside ditches and the undercutting of the relatively steep side slopes result in considerable erosion. The culverts across the roads concentrate the runoff and if improperly placed, speeds the high velocity jet from the culverts directly towards a steep valley slope causing it to undermine and erode. Steepness of slopes in road construction and lack of slope protection are additional problems.

Pattern of roads and streams in the Lake Superior basin in the vicinity of Ashland, Wisconsin.



Forestry

The original forest cover on the clays was mainly conifer. Where drainage was adequate, white pine was predominant with hemlock, cedar, spruce and balsam included. Associated hardwoods of lesser importance included yellow birch, hard maple, red oak and basswood. Burning and total removal of timber has raised the water table and increased the moisture content of the soil to such an extent that in the flatter areas we find only aspen and that of poor growth and quality.

Some forestry practices have accelerated sedimentation. When trees are harvested and hauled away, a certain amount of ground scarification is inevitable, and there is danger of erosion. Furthermore, expediency in building logging roads often dictates their location along routes which accelerate normal erosion.

On the other hand, some forestry practices retard sedimentation. Forest management strives to quickly clothe denuded soil with acceptable species by artificial means or natural regeneration, to maintain them, and to harvest them so that the remaining stems insure adequate erosion control. By their very nature, long-range forest plans call for stabilization of ownership and blocking, thus deterring unwise agricultural settlement on the rougher soil regions where plowing of the sod would encourage soil loss.

Fishery and Scenic Values

The acceleration of erosion and sedimentation in the watersheds of this area by improper land use together with natural forces has seriously marred the scenic quality and damaged the fishery of this area. Stream bank erosion is common and is a major source of sedimentation. Unsightly raw banks, heavily sedimented streams and loss of fishery resources are environmental liabilities in this area.

In extreme cases, e.g. the Whittlesey Creek, the entire fishery was destroyed. Even as recently as the early 1940's this creek was a trout stream. In the mid-1940's, there were two abnormally heavy periods of precipitation resulting in excessive sedimentation. With the exception of a few isolated spots most of the creek became a dry stream bed. For all practical purposes, the damage to the stream and the fishery habitat is irreversible.

All streams in this area are subject to various degrees of erosion and sedimentation. The rate of deterioration varies with the stage of these processes. The earliest stages of erosion are not necessarily harmful for this is the way streams are created. Generally the rate of deterioration can be significantly reduced by proper bank stabilization in most other areas of the Lake Superior basin needing attention.

Bank stabilization needs for all streams in this area were inventoried and reported in a 1964 progress report.

Economics and Implementation

Problems in soil and water management are made increasingly difficult at the present time with changing rural conditions. Because farms in the area are generally small and not always the most productive and because of the present farm cost-price squeeze, farmers have been forced to resort to off-farm employment to maintain the standard of living which they want to provide their family. Consequently, it is difficult to get farmers interested in making changes in their land-use practices, especially if it involves an outlay of additional funds.

The same is true at the town level where town officials are reluctant to invest any "extra funds" at the time of highway construction for measures which would prevent or materially reduce sedimentation of streams from roadside ditches, fills or cut banks. Actually proper highway construction and runoff control, immediate bank stabilization and adequate maintenance will not only be practical in the long run, but the natural resources will be protected now and for the future. The economy of this area is highly dependent on the correction of these problems.

•

In summary, it could be said that the control of sedimentation through improved soil and water management, improved highway construction and maintenance practices is a social, economic and political problem. Because the area is naturally susceptible to erosion, considerable damage has been done and many sites need stabilization. Special programs are required. Where possible, federal, state and local programs should be immediately implemented.

RECOMMENDATIONS

Recommendations for erosion and sedimentation control are discussed under two categories: (1) general land-use practices based on an evaluation of problems and the application of available techniques; and (2) specific recommended practices based on special studies conducted in the area.

The recommendations that are contained in this section should be implemented by all local, state and federal governments and agencies to meet their responsibilities in controlling erosion and sedimentation and achieving desirable water quality standards.

Experienced personnel trained in erosion control measures are available locally to assist town and county officials in implementing these recommendations. These include district engineers from the Division of Highways, Department of Transportation, county agents, work unit conservationists from the Soil Conservation Service and foresters and fish and game managers from the Wisconsin Conservation Division.

General Land-use Management

Agriculture

Controlling Grazing

The pasturing of woodland ravines, stream banks, waterways and gullied areas should be eliminated. High quality forage-producing areas should be developed on gentler slopes and relatively nonerodible lands and cattle should be fenced into these areas.

This means that it will be necessary to clear more Class II and Class III land where available — i.e., soils which are deep and productive but need liming, fertilization and good rotations and which can be cultivated safely with easily applied practices such as protective cover crops and simple water management operations.

Surface Drainage Systems

Land smoothing can be used to advantage on crop land in this area that is dotted with shallow surface depressions. It will result in better establishment and maintenance of high-producing stands

Cattle grazing in a side valley in the Whittlesey Watershed in 1957. Present watershed plans call for "fencing-out" cattle from such sites. Dairy production can be increased if cattle are grazed on improved upland pastures.

of legume and grass mixtures over a long rotation. The cost of this operation and resulting benefits should be carefully considered before farmers apply this practice. To minimize erosion problems one must make sure that satisfactory outlets are available on fields that are surface drained.

With the exception of occasional depressional areas, sufficient water disposal is generally provided through natural waterways. It is important to keep waterways in heavy sod cover to handle excess runoff following spring thaws and summer rains.

Waterways should be maintained by occasional mowing and fertilizing. They should never be used for roadways. Livestock should be removed in wet weather.

The topography of crop fields are level to gently sloping. Ordinarily farmers keep land in hay as long as the stand is good. This helps to keep soil erosion losses to a minimum. However, some gully and sheet erosion is showing up throughout the area. Recognized soil conservation practices should be established .

Forestry

To improve the forest cover and thus reduce erosion on forest lands in the area, it will be necessary to implement long-range plans. These include:

(1) Continue adequate protection from wild fires.
(2) Eliminate all pasturing in the woods.
(3) Properly locate and develop forest roads. Use care when skidding and hauling. Skidding and hauling on easily eroded slopes should be on the contour.
(4) In erodible areas, improve stocking of desirable species suitable for harvest by individual tree or group selection methods. Species selected should have long rotation ages and be suitable for frequent intermediate cuts.
(5) In extensive stands of aspen-paper birch, change cutting habits from progressive clear-cutting of entire stands to strip or patch cutting. Uncut patches should be designed to intercept runoff from cut areas.
(6) Stabilize ownership by blocking forest lands into management units.

Erosion taking place in Raspotnik field waterway on Highway 63 in Bayfield County. Area was reshaped, prepared for seeding, seeded and mulched.

Same waterway showing cover after two years.

Road damage caused by inadequate culvert capacity.

An adequately designed culvert with features for water control.

Highways

Relocation

The relocation of some roads can in many cases reduce the roadside erosion problem. It is suggested that when relocations are contemplated, consideration be given to erosion and stability problems which will be created by the new road.

Culvert Location

The location of culverts should be carefully considered so that the water is discharged in the direction of the natural flow through the valley. Occasionally the use of drop inlet earth dams will provide detention time that will reduce flooding downstream.

Bank and Ditch Stabilization

The stabilization of the roadside banks and ditches is one of the most serious problems in the area. Where possible excessive water should be diverted away from road banks and ditches. The raw side slopes and open ditches encourage erosion. A sod cover will provide excellent protection. Direct sodding on these steep slopes, although an ideal corrective measure, is impracticable from a cost standpoint because of the large area involved and the difficulty of working on the steep banks. Sloping, seeding and mulching as recommended in this report is the cheapest and most practical approach to establishing cover on highway banks and ditches.

Established toe stabilization should be maintained at all times.

Shore Land and Floodplain Zoning

While the best erosion and sedimentation control practices will greatly reduce problems in the area, flood damage will continue to be a serious factor in land-use management. Zoning of these areas, such as that accomplished by the Bayfield County Floodplain Zoning Ordinance of April 19, 1960, is a necessary precaution. Since zoning of shore land and floodplain areas is now a requirement under Chapter 614, Laws of Wisconsin, 1965, with special programs created for its establishment, this subject will not be elaborated in this section.

32a RESCREEN & SQUARE HALFTONES

View of Whittlesey Creek flowing in its original channel north from the Highway 13 bridge to Lake Superior in Bayfield County after dredging in 1958 according to specifications designed by the Red Clay Interagency Committee.

Prior to 1958 the creek flowed directly to Lake Superior in an artificial channel now completely filled with sediment (shown below). The artificial channel filled in every few years and the Whittlesey Creek flooded the road and adjacent lands causing severe damage. Since 1958 "the original channel" has handled the flow with no further flooding at negligible maintenance costs.

Specific Recommendations on Critical Sites

Based on the results of work by this committee on numerous sites, the following recommendations for seeding and mulching to achieve effective stabilization of red clay areas subject to severe erosion and rapid water runoff are specifically set forth:

Seeding

Because of the frequent sloughing and slippage on red clay cut and fill slopes due to moisture collecting in the soil from seepage and/or natural runoff, it is also recommended that the alignment of the roadway be adjusted so as to reduce or eliminate side hill cut and fill sections by crossing the natural contours at right angles.

1. Banks — Cuts, Fills and Gullies

   a. Sloping and Seed Bed Preparation
   Before seeding, the back slopes should be cut and graded to a 3:1 or flatter slope and fill sections constructed to a 4:1 slope. Wherever possible a satisfactory seed bed should be prepared.

   b. Fertilizer Application
   Apply 500 pounds of 10-10-10 per acre. Where straw mulch is used additional nitrogen is advisable. No lime is generally needed since the road bank cuts are usually in calcareous subsoil.

   c. Seed Mixture
   The seeding mixture per acre for these critical areas should consist of either:

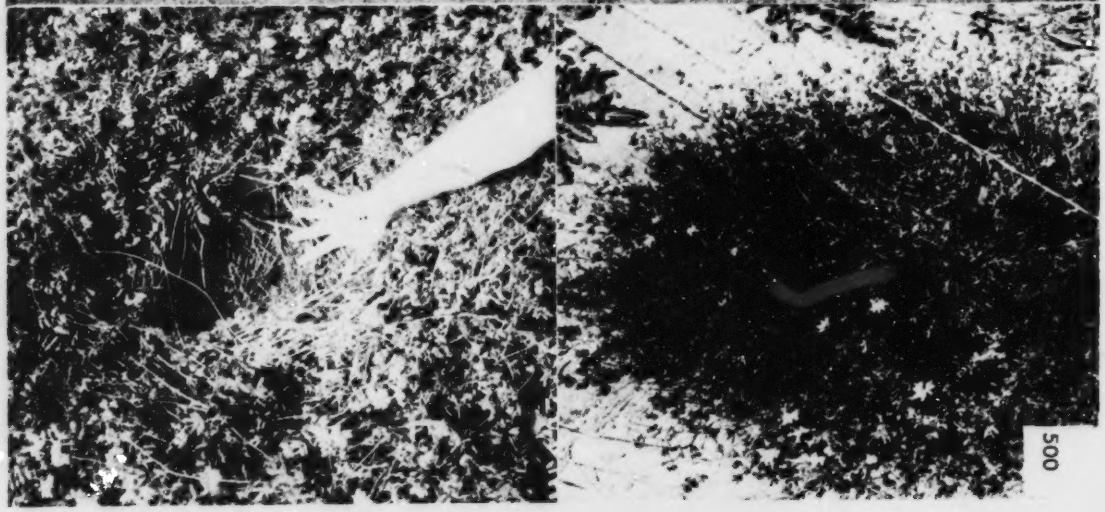
   (1) 10 pounds smooth brome (Canadian brome or variety Sac);
   6 pounds Empire bird's-foot trefoil; and
   5 pounds tall fescue (Alta or Kentucky 31); or

Steep road bank showing slippage even with a sod cover.

Preparing seed bed on properly formed roadside bank using the Finn Klodbuster to fill in rills (left).

Hydroseeding a road bank on Highway 13 using Finn Company equipment (right).

Successful road bank stabilization on Highway 112, Ashland County. This bank was properly sloped, seeded and mulched.



Two excellent legumes for stabilizing road and stream banks in the red clay area of northwest Wisconsin. Crownvetch (left) shows blossoms, foliage and ground cover capacity. The tremendous spreading and ground cover growth of a single bird's-foot trefoil plant is shown on the right.

(2) 5 pounds crownvetch;
    5 pounds Empire bird's-foot trefoil;
    5 pounds smooth brome; and
    1 pound Kentucky bluegrass.
    (Note: Special inoculation is required for bird's-foot trefoil and crownvetch.)

d. Time of Seeding

Seed as early in the year as practical but not later than July 15. "Mudding-in" of seed is not recommended. Seeding can be made with conventional grass seeders, hydroseeders or by hand. Seeding must be protected with an adequate mulch.

e. Maintenance

After the desired legumes and grasses become established, mowing is not considered necessary except for weed control. Subsequent fertilizer treatments may be desirable — these should be applied as necessary in spring or early fall. *Do not spray* legumes with herbicides.

2. Grassed Waterways

a. Slope and Seed Bed Preparation

The waterway must be properly designed and shaped.

b. Lime and Fertilizer Application

Get a soil test and apply lime and fertilizer accordingly. If available, spread evenly 8-10 loads of barnyard manure per acre. Work the fertilizer and manure into the top 3-4 inches of soil. Seed after discing and mulch immediately if a companion crop is not used.

c. Seed Mixture

Smooth brome is the most desirable ingredient in a waterway seeding mix, although some tall fescue is desirable along with Empire bird's-foot trefoil. The grass waterway seeding mixtures per acre should consist of:

(1) 15 pounds smooth brome (Canadian brome or variety Sac);
(2) 9 pounds tall fescue (Alta or Kentucky 31; and
(3) 6 pounds Empire bird's-foot trefoil.

Wet waterways should be seeded with 10 pounds of reed canary grass per acre.

d. Companion Crop

When mulch is not used, a companion crop is desirable. Use 2-4 pecks of oats per acre.

3. Stream Banks

a. Sloping and Seed Bed Preparation

Tops of slopes should be rounded to remove overhangs. Rills and gullies should be filled where possible. High velocity drainages should be diverted before runoff reaches the face of the slope.

b. Toe Stabilization

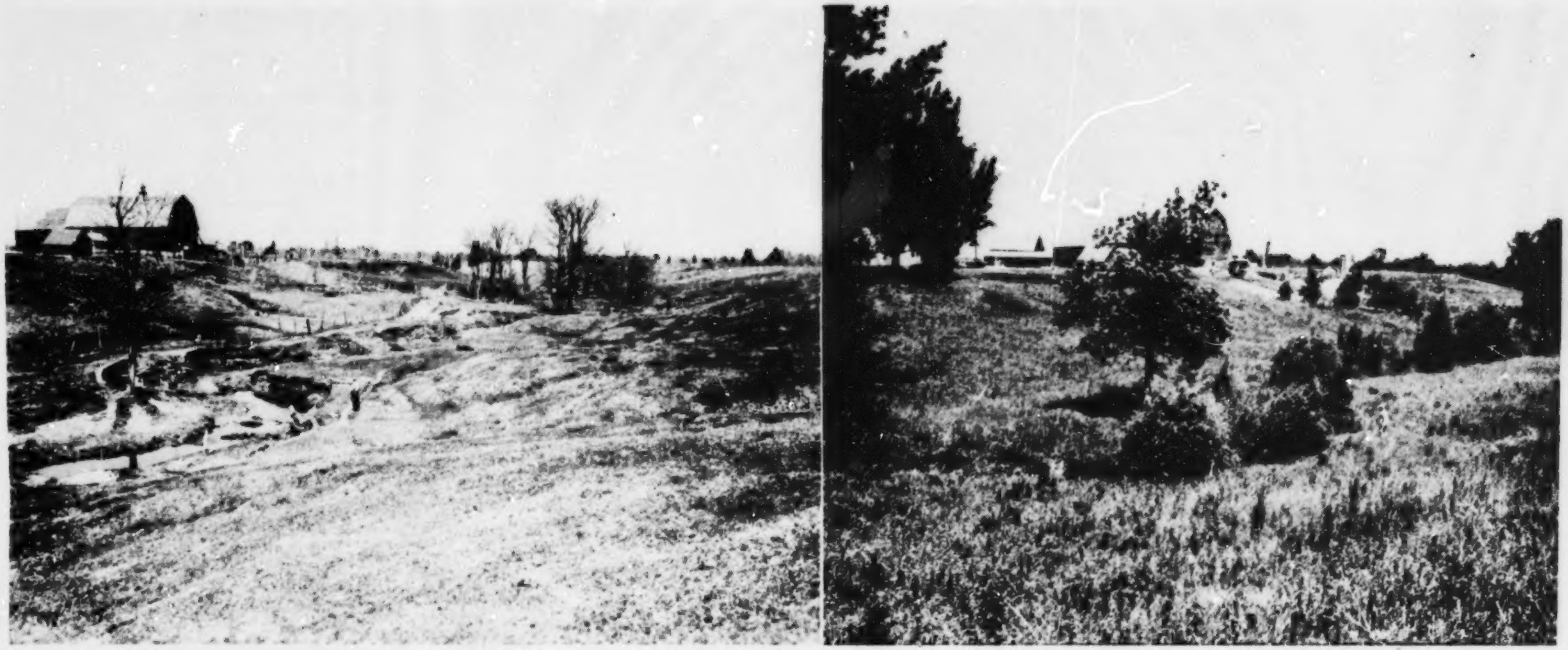
Wherever bank erosion is occurring or is potential, toe stabilization is necessary to prevent stream deterioration and at times complete destruction through sedimentation, as in the case of the Whittlesey Creek. Several techniques were tested.

The installation of Gabions at the toe of the bank is one of the best practices. These consist of wire baskets filled with rocks. (Use #9 gauge or heavier wire which should be made from corrosion-resisting metal.) While installation is relatively simple, assistance should be solicited from Conservation Division and Soil Conservation Service personnel. The use of rock rip-rap backed by a suitable bed of filter material is also an excellent means of toe stabilization.

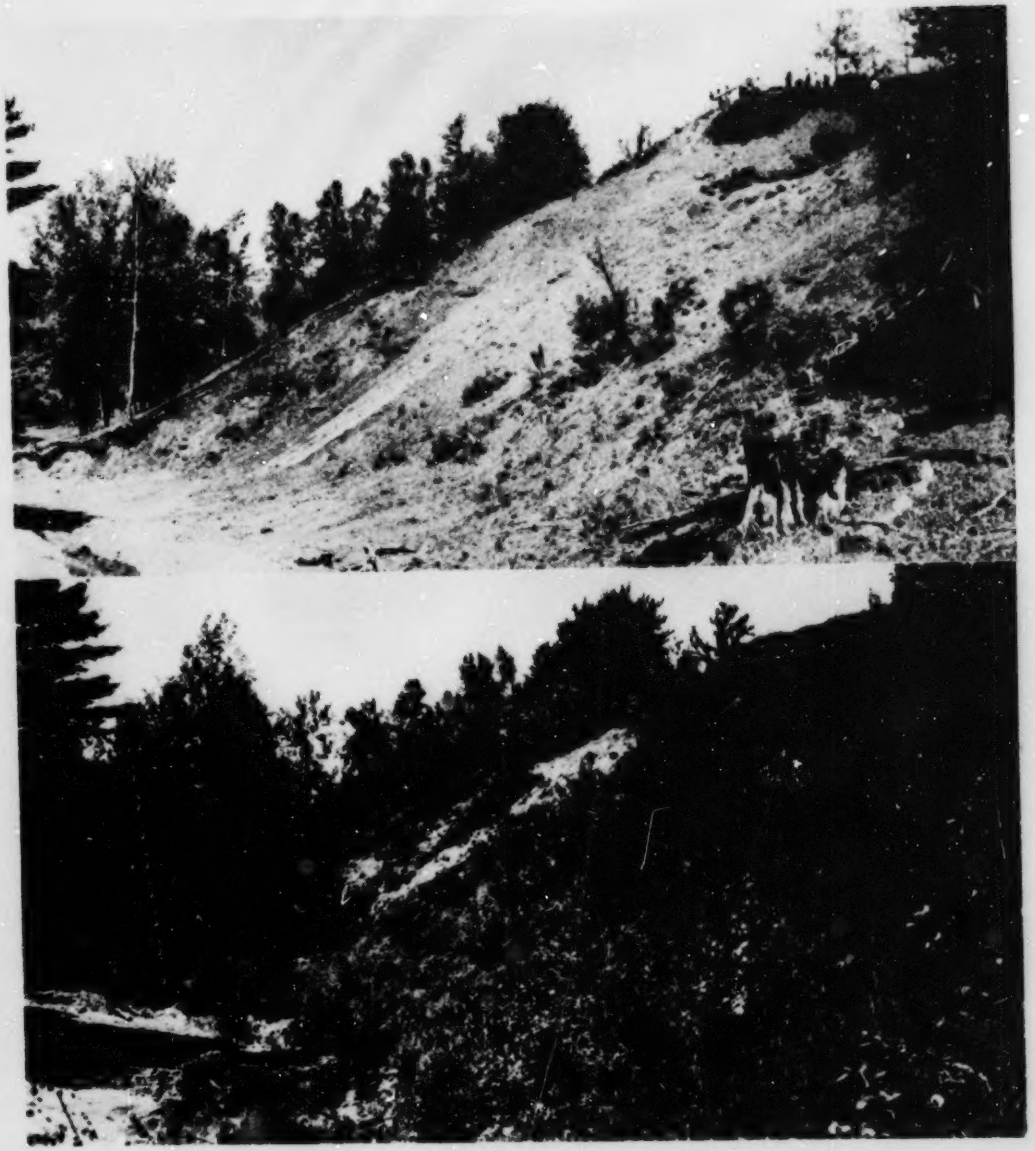
Installation of sheathing and deflectors and stream diversion are other important methods of toe stabilization and protection. Measures to stabilize the toe of slopes must extend vertically to the high water elevation.

c. Seeding and Mulching

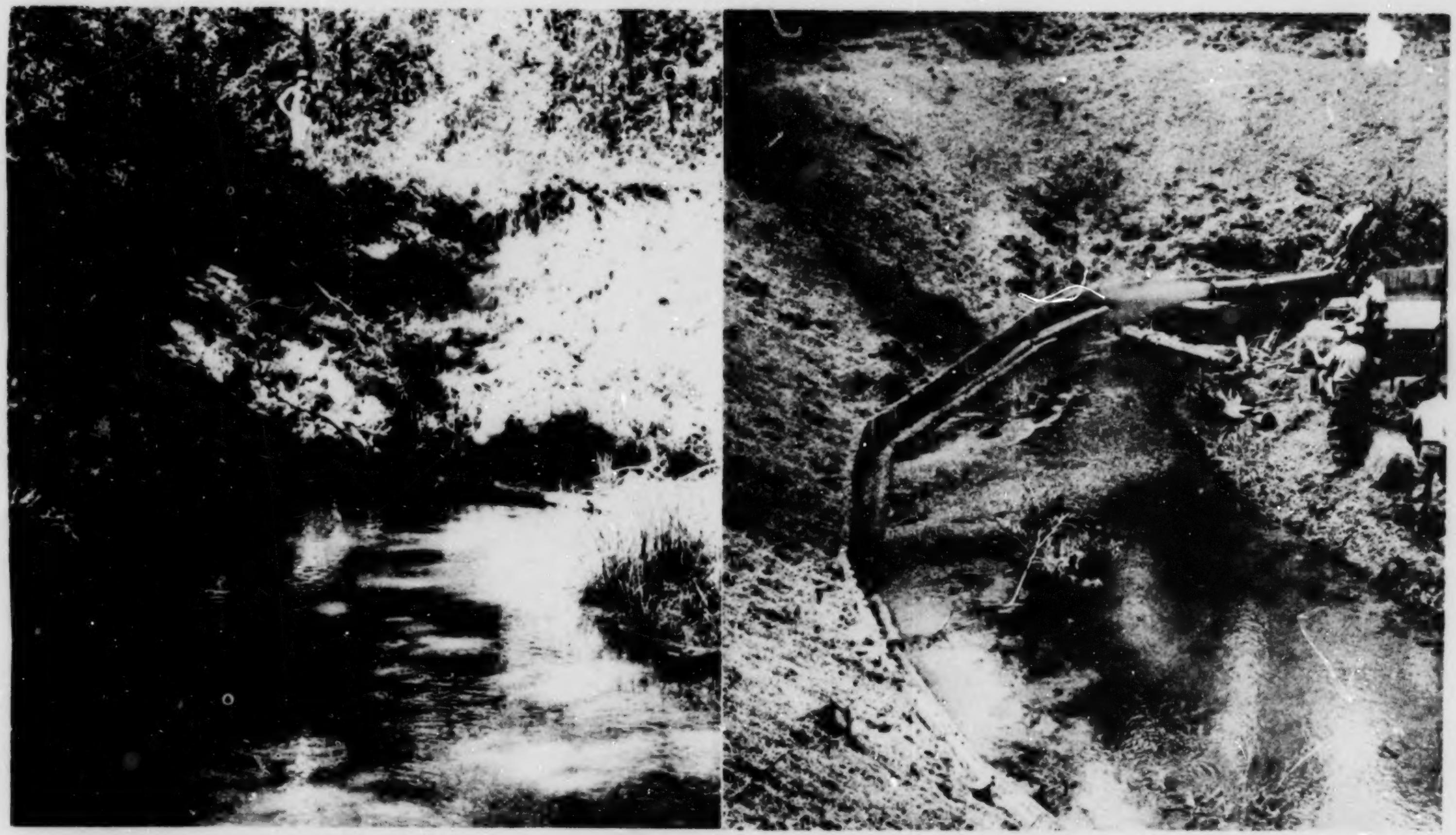
After achieving adequate toe stabilization, reed canary grass at 10 pounds per acre or spriggings (sod pieces) with one foot spacing should be used at the waterline. For critical areas above the waterline use the seeding recommendation for banks. Mulch in accordance with the recommendations in the next section.



Eroded banks in drainage area southeast of Ashland — before improvement and 4 years after improvement.



Stream bank in Whittlesey Watershed with 82 percent slope. Upper picture shows condition before stabilization in 1958 (note overhang). Lower picture, same bank relatively stabilized with good cover development after overhang was removed, bank seeded and field runoff was diverted from top of bank.



Picture of stream bank stabilization at Elk Creek in Eau Claire County using Wakefield sheet piling for toe protection. The picture on left shows "overhang" on the raw, steep bank. In picture on right, overhang is removed, bank properly sloped, seeded and in process of being mulched. This bank has been completely stabilized since 1959.

Stream bank toe stabilization with Gabions (wire baskets filled with rock) in the Brule River Watershed, Douglas County, 1966.

Stream channel diversion to original bed in the Whittlesey Watershed.

Mulching — For Roads, Stream Banks, Grassed Waterways

A good mulch applied immediately after seeding and held in place is essential in establishing seedings and reducing runoff on exposed red clay soils. The following mulching materials were used and the results provide the basis for recommended practices.

1. On Slopes and Adjacent Flat Areas
    a. Straw-asphalt

This mulch gave excellent results at all sites. Application requires specialized equipment and to date has been the most economical material. Good results were obtained when 150 gallons of water-emulsifiable asphalt (type S.S.-1) and 1½ to 2 tons of straw were applied per acre. If cereal straw is the mulch, it should be relatively free of grain and weed seed. Marsh hay is not a good substitute for straw when using special mulching equipment as it binds in the mulcher and spreads unevenly. However, it is an excellent mulch when appropriate means of spreading are available. If mulching equipment is not available, marsh hay and straw may be spread by hand. It is suggested that this material be tied down by jute netting or other similar materials. Mulch should be applied to a thickness of 7-8 stems. Occasionally some bare soil should be visible.

Mulching a road bank with straw and asphalt along Highway 13 near Cornucopia, Bayfield County, with Finn Company equipment.

b. Wood Cellulose

Turfiber* (no longer available) has been used with limited success on red clay soils. Similar wood cellulose products are currently available but have not been tested by the committee. These materials are applied as a slurry with seed and fertilizer admixture in one application using a hydroseeder. Wood cellulose, when applied at the recommended rate of 1,000 pounds per acre, compares favorably in cost with the straw-asphalt mulch and is easier to apply. However, this material is not recommended on red clay soils at this time unless further studies can show its effectiveness.

c. Glassroot*

A fiber glass product manufactured by the Pittsburgh Plate Glass Company has given excellent erosion control, but its expense at this time precludes usage on large areas even though application is relatively simple. A special inexpensive applicator and air compressor are required. Glassroot comes in 35-pound balls. The rate of application and cost, manufacturer's list:

On Slopes: Rate — 800 pounds per acre
Cost — 5.5-6.3¢ per square yard
In Ditches: Rate — 1,000 pounds per acre
Cost — 7.5-8.5¢ per square yard

The cost varies with the amount of Glassroot purchased. The above costs are for material only.

d. Other mulching materials made of wood fiber, jute, nylon, plastics, etc., are available but since these were not intensively studied they are not specifically recommended.

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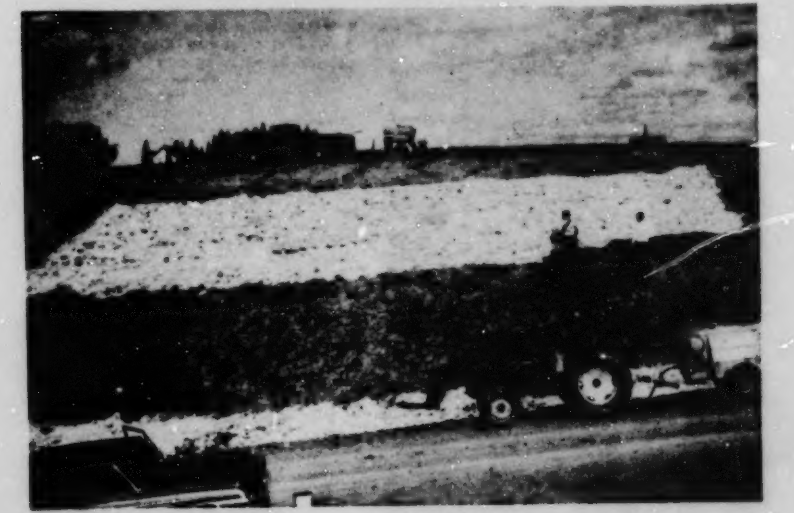
* Trade names.

Applying Glassroot in road ditch, Town of Eileen, Bayfield County, 1968. After hydroseeding, this road ditch is now completely stabilized.

The road bank in Town of Eileen after properly sloping to 3:1 grade, also showing Glassroot on mulch plot and in road ditch.



2. On High Velocity Waterways and Road Ditches

Generally field waterways can be mulched as recommended for slopes and adjacent flat areas. However, in steep-sloped areas and rapidly draining road ditches, mulch which will not be carried off by the fast flowing waters should be used. Grade stabilization structures may be needed on very steep channels in order to maintain bottom gradient. Potential material for these purposes is described as follows:

a. Soil Saver (Ludlow product)*

This is a heavy jute mesh. It comes in 12'x 225' rolls. It gave good erosion control when applied in a roadside ditch. No special equipment is necessary, but its use is largely dependent upon availability of hand labor. Cost — the average cost, laid in place, for Wisconsin in 1968 was 64¢ per square yard.

b. Glassroot*

Depending on future availability, cost and site condition, Glassroot has good possibilities for use in road ditches and other high velocity waterways. (For rate of application and cost, see previous discussion of use of Glassroot "On Slopes".)

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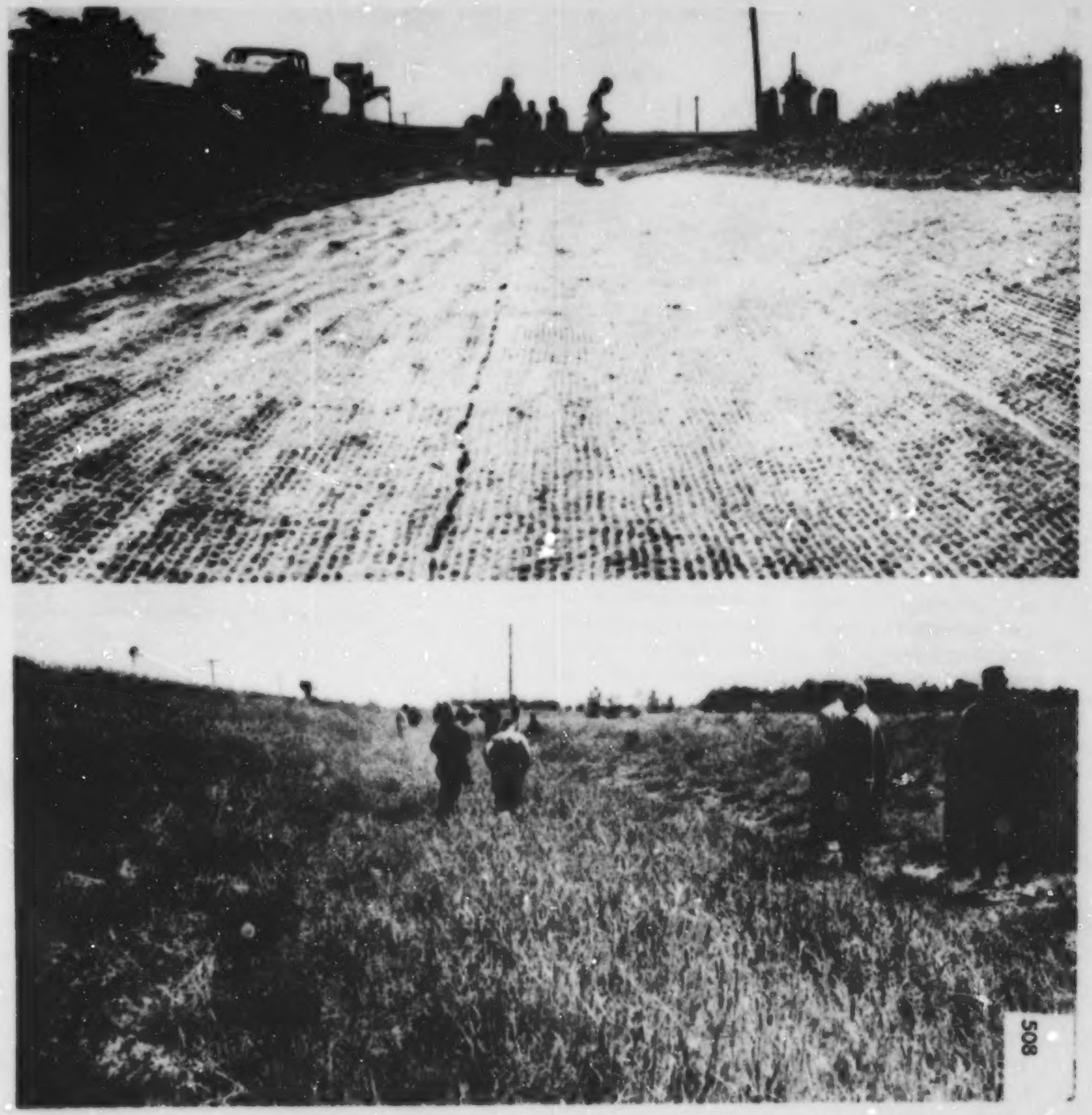
* Trade names.



Soil Saver being applied after seeding in a road ditch along Highway 112 in Ashland County (upper picture). In the lower picture the road ditch is stabilized.

APPENDIX:

DEVELOPMENT AND RESEARCH SUMMARY

Approaches to the solution of the land-use problems involved:

Applying available techniques to problem areas.
Testing promising techniques.
Developing new techniques.

Actually, all approaches were employed at most sites selected for development or study; only the degree of emphasis varied. The procedures included first a review of both natural problems and those resulting from various land-use practices carried out in the area. This review resulted in the identification of sites where available techniques could be carried out, what studies were needed, and where.

Since the primary consideration was sedimentation control, the land-use programs were reviewed in this context. Only those phases of land-use programs unique to the sedimentation problem were considered.

Applying Available Techniques

The following are the land uses that were reviewed and the plans and programs that were put into effect:

Agriculture — Reviewed problems. Developed conservation farming plans and assisted in putting them into practice.

Highways — Evaluated bank stabilization needs. Fertilized, seeded, mulched and developed cover on road banks on seven sites.

Forestry — Reviewed problems and developed study plans.

Water Management and the Fishery — Reviewed the history of the fishery of the area. Improved the Whittlesey Channel and assisted in preparing floodplain zoning ordinances in the Towns of Eileen and Barksdale. Inventoried 1,362 miles on 211 streams in four counties and classified them for bank stabilization needs. Surveyed stream bank fencing needs and assisted in carrying out this practice.

Game — Reviewed the history of game populations and status in the Whittlesey Watershed.

Special Studies

Road and Stream Bank Stabilization

1. Mechanical Improvements
   a. Slopes
      Seed bed preparation on old sites — removed rills by dragging with the Finn Company Klodbuster, discing and raking. Installed log-checks and laid 3-M plastic mats.
   b. Toe Stabilization
      On the Whittlesey Creek
         Installed cement bag deflectors
         Planted willows
         Diverted the stream bank to natural course
      On the Brule River
         Installed Gabions (wire baskets filled with rocks)
2. Determining Seeding Mixtures and Fertilizer Application (rate and types)

Established Study Plots at:
  Whittlesey Watershed — 1958 - 1962
  Sand River (Highway 13) — 1959
  Town of Eileen — 1959 - 1963
  White River — 1960
  Wanabo Road — 1964

3. Developing Mulching Techniques
   - a. Equipment used — Evaluated Finn Company Hydroseeder, Mulcher and Klodbuster
   - b. Materials Used
     Primary — Straw-asphalt
       Turfiber (International Paper Company product)
       Glassroot (Pittsburgh Plate Glass Company product)
       Soil Saver (Ludlow jute-mat product)
     Secondary — Several miscellaneous products including resins, nylon mats, mist nets, etc.

Controlling Runoff Waters

1. In Field Waterways
   Formed, seeded and mulched Hunt and Raspotnik Waterways in Town of Eileen, Bayfield County. Tested seed mixtures and mulching methods.
2. In Road Ditches
   Installed Ludlow Soil Saver and tested various seed mixtures in the White River experimental site.
   Applied Glassroot and tested various seed mixtures in Town of Eileen experimental site.
3. Channel Improvement
   Diverted Whittlesey Creek near intersection of Highways 2 and 13 to original channel by dredging.

Forestry

1. Established experimental planting on furrows.
2. Seeded several species of trees and shrubs using "Globseeding" technique which involves applying a slurry of Turfiber, Glassroot and fertilizer with the Finn Company hydroseeder.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Division of Environmental Protection

Madison, Wisconsin 53701
October 23, 1968

REPORT ON THE WATER QUALITY SURVEY IN WISCONSIN WATERS OF LAKE SUPERIOR MADE DURING JULY, 1968

GENERAL INFORMATION

Drainage Basin: Lake Superior
Drainage Basin 28

Area Surveyed: Wisconsin and Boundary Waters of Lake Superior

Donald R. Winter

Donald R. Winter
Biologist

DRAINAGE AREAS AND USES

Lake Superior drains approximately 3,200 square miles of northern Wisconsin including portions of Douglas, Bayfield, Ashland, and Iron Counties. The drainage area extends between the St. Louis River and the Wisconsin-Minnesota boundary on the west to the Montreal River or the Wisconsin-Michigan boundary on the east, a distance of approximately 100 miles. The area extends inland from Lake Superior an average of about 30 miles. The following is a table of Wisconsin drainage areas in square miles for river systems tributary to Lake Superior:

Amnicon -	130 Sq. Mi.	Middle -	50
Bad -	1,016	Montreal -	180
Bois Brule -	185	Nemadji -	177
Fish -	139	Poplar -	46
Flag -	71	St. Louis -	77
Iron -	150	Sioux -	96
		Siskiwit -	31

Lake Superior is a tremendous asset to this region of the state. Its great size and generally good water quality make it important for shipping, pleasure boating, commercial and sport fishing, potable water supplies, and asthetic value.

POTENTIAL SOURCES OF SURFACE WATER POLLUTION

The Lake Superior Drainage Basin in Wisconsin is sparsely populated with relatively little industry. Though surface waters in the basin are generally of good quality, localized problems do exist in the vicinity of some communities and industries as described in the April 28, 1966 Report On An Investigation of the Pollution in the Lake Superior Drainage Basin, made during 1965 and early 1966 by the former Wisconsin Committee on Water Pollution. The following is a list of potential sources of surface water pollution within the Wisconsin section of the Lake Superior Drainage Basin:

Source	Type of Waste
American Can Co. - Ashland Div.	Paper
Andersonville Co-op Dairy Assn.	Milk
Ashland, City	Sewage
Bayfield, City of	Sewage
Bodin Fisheries	Fish Processing
Douglas Co. Hospital and Sanitary	Sewage
E. I. du Pont de Nemours and Co.	Chemical
Evertt Fisheries, Inc.	Fish Processing
Farmers Cheese Factory	Milk
Fuhrmann's South Shore Dairy	Milk
Great Northern Railroad Company	Oil
Hurley, City of	Sewage

Iron Belt, Unincorporated	Sewage
Iron River, Unincorporated	Sewage
Koppers Company	Chemical
Marengo Co-op Dairy Assn.	Milk
Martens Dairy	Milk
Mason Milk Products	Milk
Mellen, City of	Sewage
Middle River Sanitorium and Douglas Co. General Hospital	Sewage
Montreal, Village of	Sewage
Moquah Cheese Factory	Milk
Mountain Valley Cheese Factory	Milk
Murphy Oil Corporation	Oil
Ondassagon School	Sewage
Pence, Town of	Sewage
Penokee Veneer Company	Wood
Pureair Sanitorium	Sewage
Ruppe Cement Company	Silt
Sand Bay Fisheries	Fish Processing
Saxon, Town of	Sewage
Soo Ling Railroad Company	Oil
Stott Briquet Company	Coal
Superior, City of	Sewage
Superior Fiber Products, Inc.	Paper
Superior, Village of	Sewage
Twin Ports Dairy	Milk
Union Tank Car Company	Oil
Washburn, City of	Sewage

DISCUSSION OF PARAMETERS AND SURVEY FINDINGS

Bottom Samples - Table I

Bottom samples were collected with a Petersen Dredge, the macro invertebrates concentrated with a standard thirty mesh screen, preserved in the field, then tentatively identified and enumerated in the laboratory. Of the very tolerant organisms, sludgeworms were by far the most numerous. Those sampling sites supporting in excess of 100 very tolerant organisms per square foot are considered organically enriched. This includes sample sites 1, 2, 3, 5, 6, and 7 in the St. Louis River mouth and Duluth-Superior harbor (Superior Bay). Current is reduced in Superior Bay and the physical habitat is characteristic of a shallow lake. The water quality is that of the river and is not comparable to the water quality of the lake. The influence of the St. Louis River on the bottom fauna in the west end of Lake Superior is limited to approximately three miles offshore. Though results are inconsistent within three miles of Wisconsin and Minnesota Points, several samples including numbers 9, 26, 29, 30, and 33 indicate some enrichment. The inconsistency, at least in part, can be attributed to variation in microhabitats in this area. Those sites with an accumulation of organic debris produced the higher numbers of very tolerant organisms. The habitats composed primarily of sand or hard clay were less productive. Wave action, dredging near the Duluth and Superior entrances and boat traffic may also influence the distribution and quantity of organisms in this area. Samples

10 and 20 in boundary waters contained an unusual, thin, hard, black strata found in no other area of the lake. This should be studied further as to origin, distribution, and significance.

Bottom samples in the vicinity of American Can Company, Ashland Division, in Chequamegon Bay revealed a severely altered habitat. Samples 70 and 71 collected approximately 100 and 300 feet off the American Can Company outfall respectively, were predominately wood fibers which have destroyed the habitat for bottom organisms. No organisms were found in either sample. Sample 70 also contained pieces of film plastic and foil and sample 71 was extremely odorous. Pieces of film plastic were also noted either in bottom samples or in the water at stations 67, 68, 69, 73, and 74, in Chequamegon Bay, and at the public boat landing at the northeast end of Ashland. Pieces of plastic are reportedly found periodically in the Apostle Island region, however, none were observed during this survey. Sample 69, approximately 0.5 miles off American Can Company, indicated organic enrichment with over 900 very tolerant organisms per square foot. Fibers were not in evidence at this station but film plastic was again noted. Sample 73, 0.5 miles off the Ashland ore docks, also showed enriched conditions.

Most other bottom samples throughout the Wisconsin waters of Lake Superior indicated relatively unproductive conditions which are characteristic of an oligotrophic lake. Pontoporeia affinis, an amphipod, was the most common intolerant form. Substantial numbers of the intolerant mayfly, Hexagenia sp. were collected from Chequamegon Bay.

Dissolved Oxygen - Table I

Dissolved oxygen sampling was limited to the vicinity of waste sources and the area off Superior Bay. The dissolved oxygen concentration at station 4-A, 10 feet off Superior Fiber Products, Inc. lagoon overflow, was 0.0 milligrams per liter and was the only value recorded which would be critical for aquatic life. The concentration 300 feet off the Superior sewage treatment plant was 8.5 milligrams per liter. Other values in the St. Louis River and Superior Bay ranged from 4.3 to 6.5 milligrams per liter. Values of 10.9 and 11.3 were found 1.5 miles off the Superior entrance and were near the saturation value.

A dissolved oxygen sample 100 feet off the American Can Company at Ashland could not be titrated due to some unknown chemical interference. Samples 300 feet and 0.5 miles off the outfall had concentrations of 8.4 and 9.2 milligrams per liter respectively. Surface and bottom values of 9.5 and 8.8 milligrams per liter were found 50 feet off the Ashland sewage treatment plant. More extensive dissolved oxygen sampling was not conducted in open waters as the general low productivity does not lower oxygen levels in the hypolimnion if indeed a true hypolimnion develops. Beeton (1965) reported saturated dissolved oxygen concentrations at all depths in Lake Superior.

Secchi Disc Readings and Turbidity - Table II

Secchi disc readings and laboratory Hack turbidity measurements are quite closely related as they are both a function of water transparency dependent on suspended solids such as clay or silt, plankton concentrations, and color. The lowest turbidity measurement, 0.08 was in the vicinity of South Twin Island. As a comparison the most turbid water in the lake was found 100 feet off American Can Company, Ashland, where the measurement was 54.00 due to the large amount of suspended fibers in the water. The secchi disc at this point was only 1 foot as compared to a range of 2 to 13 feet elsewhere in Chequamegon Bay. In general, turbidity in Chequamegon Bay is due to diatoms, and suspended clay particles. Secchi discs in the St. Louis River mouth and Superior Bay ranged from 1 foot inside the Superior entrance to 2.5 feet inside the Duluth entrance. A maximum secchi disc of 23 feet was recorded off Stockton Island.

Plankton Samples - Table II

A Clarke Bumpus plankton sampler with a 20 mesh net was used to collect surface water plankton. The samples were concentrated and preserved in the field for laboratory analysis. Three different observers analyzed, microscopically, a representative portion of each sample for percentage composition by volume. Copepods, cladocerans and ostracods were most predominate among the zooplankton. Melosira sp. was the most common diatom except in Chequamegon Bay where Tabellaria sp. predominated. Very few blue-green algae were noted in the samples with Aphanizomenon sp. the most common genera. In some cases substantial quantities of inorganic and organic debris were present in the samples. Inorganic debris is primarily sand or clay and organic debris includes plant fragments, insect fragments, exuviae and the like. Each sample was dried and analyzed for total, fixed, and volatile solids, the results of which are expressed as micrograms of solids per liter of water filtered. The volatile solids is of particular importance since it is a measure of production which is related to the trophic condition of the water. In many lakes it is the volatile solids in the water which is most objectionable from a recreational and aesthetic point of view. Characteristically those lakes with substantial algae blooms are of an eutrophic nature and will produce a high volatile solids concentration in the surface waters. Concentrations of 2,500 micrograms per liter are not uncommon in very productive lakes. Total solids of 5,000 micrograms per liter have been recorded. The most oligotrophic or least productive lakes in Wisconsin with no ice cover generally support less than 100 micrograms volatile solids per liter, and some are occasionally less than 5 micrograms per liter. With large concentrations of diatoms, the percentage of fixed solids may increase as silicates are incorporated into the cell structure.

All solids results were relatively low except those in Chequamegon Bay with some increase also noted in the Bayfield and Long Island areas. Sample number 70, 100 feet off American Can Company, had an unusually high percentage of volatile solids compared to other Chequamegon Bay samples. The sample contained approximately 70 percent fibers. Other samples in Chequamegon Bay and the Bayfield and Long Island areas were predominately Tabellaria sp.

Nutrients (Volatile Solids) - Table III

Total organic nitrogen is that nitrogen bound organically in plankton and organic detritus and thus another measure of production or trophic conditions. Values in the St. Louis River and Superior Bay ranged from 0.83 to 0.98 milligrams per liter compared to 0.27 milligrams per liter only 1.0 miles off Superior Bay at station 12. Organic nitrogen in other areas of the lake ranged from 0.10 milligrams per liter near South Twin Island, station 54, to 0.18 milligrams per liter 3.0 miles off Superior Bay, station 14. Organic nitrogen concentrations were less variable in Chequamegon Bay ranging from 0.19 to 0.26 milligrams per liter. Inorganic nitrogen, that which is available for organic production, had a maximum of 0.76 milligrams per liter in the St. Louis River and a minimum of 0.242 milligrams per liter near South Twin Island and at 55 miles on the center transect (station 20). Inorganic nitrogen values in Chequamegon Bay ranged from 0.293 to 0.446 milligrams per liter. A concentration of 0.30 milligrams per liter of inorganic nitrogen at the beginning of the active growing season is often considered capable of producing nuisance algal populations (Sawyer 1947).

Soluble phosphorous showed a pattern similar to inorganic nitrogen with a maximum concentration in the St. Louis River - Superior Bay region of 0.058 milligrams per liter at station 6. Only one comparably high value was noted in Chequamegon Bay and that at station 67, 5.0 miles off Fish Creek. Soluble phosphorous values were inconsistent in Chequamegon Bay and a pattern could not be established from the data obtained. Soluble phosphorous values for the lake in general were less than 0.01 milligrams per liter, the value considered necessary for nuisance algae conditions (Sawyer 1947). Total phosphorous concentrations are related to production and the pattern established is comparable to that of total organic nitrogen.

Also included in Table III are volatile solids concentrations showing the direct relationship between nutrient and plankton concentrations.

Cladophora Growths - Table IV

Observations were made to determine the extent and distribution of Cladophora sp., a green, filamentous algae which typically grows on wave washed rocks, pilings, or other suitable substrate. These growths have reached nuisance proportions in some shoreline areas of Lake Michigan and other lakes. In general, Cladophora growths were quite variable but no where approached the nuisance proportions experienced in regions of Lake Michigan.

Commercial Fish Net Slimes

Numerous complaints have been received principally from the Bayfield area, regarding slime growths of recent origin which foul fishermen's nets. It is reported accumulations are occasionally so heavy that nets are difficult to lift. Several requests for samples of this slime growth were made but only one sample was received. The sample was collected on July 13, 1968 from float nets set in Big Bay on the east side of Madeline Island. Microscopic examination of the sample revealed virtually all diatoms with Tabellaria sp. predominating along with a few cells of Fragilaria sp. Similar slime growths on fish nets have been documented along the Minnesota shore of Lake Superior (Putnam and Olson 1961). It seems unlikely that these growths can be associated with any known sources of pollution.

Conclusions and Recommendations

In general, the Wisconsin waters of Lake Superior are of extremely high quality. In several localized areas, however, the water quality is impaired by waste discharges as explained previously in this report. Every effort should be made towards abatement in these situations to protect the lake from accelerated eutrophication.

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LAKE SUPERIOR WATER ALITY SURVEY
JULY, 1966

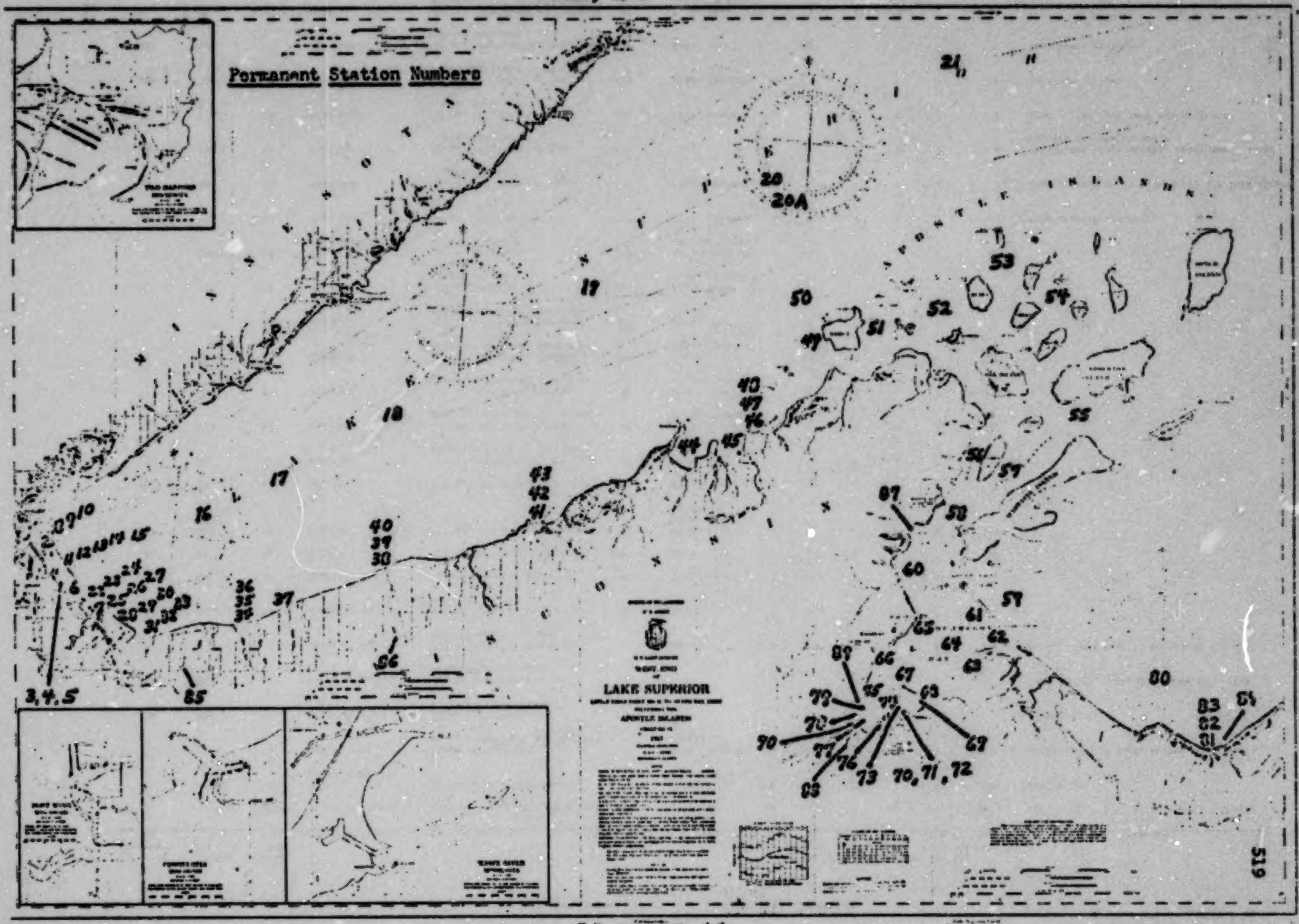

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TABLE 1
STATION, BOTTOM SAMPLES, AND [illegible]AL OBSERVATION SUMMARY
LAKE SUPERIOR, [illegible]ly, 1968

Permanent Station No.	Field Station No.	July, 1968 Date	Sample Area	Location	Approximate Depth (Ft.)	Bottom	Classification (No./Sq. ft.) Intolerant		Tolerant		Very Tolerant		Remarks
							Spp.	No.	Spp.	No.	Spp.	No.	
1	1N,21,C	10,11	St. Louis River	Upstream from the High Bridge	20	Silt, sand	0	0	4	38	3	1902	Surface DO 6.2 mg/l, Bottom DO 5.8 mg/l.
2	2N,22	10	Duluth Superior Bay	Inside Duluth Entrance	28	Silt, sand, organ. debris	0	0	1	1	4	129	Wood chips.
3	1	8	Superior Bay	South of Superior Fiber Products Lagoon Outfall	2	Silt, organic debris	0	0	0	0	1	2809	Surface DO 6.1 mg/l, Bottom DO 4.3 mg/l.
4A	D06	11	Superior Bay	10 ft. off Superior Fiber Products Outfall	2								DO 0.0 mg/l.
4B	D06	11	Superior Bay	100 ft. off Superior Fiber Products Outfall	4								DO 5.5 mg/l, Effluent cloudy tan color.
5	2	8	Superior Bay	500 ft. east of Superior Fiber Products Outfall	5	Sand	0	0	1	1	2	198	Surface DO 5.0 mg/l, Bottom DO 6.5 mg/l.
6	3N,20	10	Superior Bay	0.5 mi. west of Sky Harbor Airport	12	Silt	0	0	3	29	1	151	
7	4N,19	10	Superior Bay	Inside Superior Entrance	25	Silt, sand	1	2	2	3	3	320	
8	25	11	Duluth	0.5 mi. off Duluth Entrance	45	Sand	1	2	1	1	2	10	
9	26	11	Duluth	1.5 mi. off Duluth Entrance	60	Sand, clay, organ. debris, cinders	0	0	3	10	2	105	
10	23	11	Duluth	3.0 mi. off Duluth Entrance	80	Sand, cinders	0	0	1	1	1	1	
11	28	11	Superior	0.5 mi. offshore, between Superior & Duluth Entrances	30	Hard sand	0	0	1	5	1	1	
12	13N	17	Superior	1.0 mi. offshore, between Superior & Duluth Entrances	65	Sand, clay, organ. debris	0	0	0	0	0	0	
13	27	11	Superior	1.5 mi. offshore, between Superior & Duluth Entrances	70	Sand, clay, organ. debris	1	14	4	11	2	75	
16	36	11	Superior	3.0 mi. offshore, between Superior & Duluth Entrances	80	Sand, clay, organ. debris	1	21	3	8	1	87	
14	14N	17	Superior	3.0 mi. offshore, between Superior & Duluth Entrances	80	Sand, clay	0	0	0	0	1	1	
15	15N	17	Superior	5.0 mi. offshore, center transect	100	Silt, soft clay, cinders	1	58	2	6	1	41	
16	16N	17	West end Lake Superior	10 mi. offshore, center transect	140	Soft clay, org. debris, cinders	1	22	1	1	1	18	
17	17N	17	West end	15 mi. offshore, center transect	210	Clay, cinders	1	8	0	0	1	4	Some grayish sediment.
18	18N	17	West end	25 mi. off Superior Bay, center transect	350	Clay, cinders	1	4	1	1	1	3	Some grayish-black sediments, 1/8 inch strata.
19	19N	17	West end	40 mi. off Superior Bay, center transect	530	Clay	1	3	0	0	0	0	Thin, hard black strata, heavy seas, water appears greenish-brown.
20	20N,4	18	West end	55 mi. off Superior Bay, center transect	530	Clay, cinders	1	3	0	0	1	2	1/32 - 1/16 inch hard black strata.
20A	20NA	18	West end	55 mi. off Superior Bay, 2 mi. southeast of 20	450	Clay, cinders	1	3	0	0	0	0	No black strata.
21	21N	18	West end	70 mi. off Superior Bay, center transect	430	Sand, clay	1	18	1	3	1	31	Some black sediment.
22	31	11	Superior	0.5 mi. northwest of Superior Entrance, 0.5 mi. offshore	30	Sand, clay organ. debris	1	1	2	3	1	13	

TABLE I

Permanent Station No.	Field Station No.	July, 1968 Date	Sample Area	Location	Approximate Depth (Ft.)	Bottom	Classification (No./Sq. ft.) Intolerant Spp.	Intolerant No.	Tolerant Spp.	Tolerant No.	Very Tolerant Spp.	Very Tolerant No.	Remarks
23	30	11	Superior	0.5 mi. northeast of Superior Entrance, 1.5 mi. offshore	35	Sand	0	0	3	3	0	0	Some black sediment.
24	29	11	Superior	0.5 mi. northeast of Superior Entrance, 3.0 mi. offshore	85	Sand, clay	1	13	3	3	1	9	
25	3	9	Superior	0.5 mi. off Superior Entrance	45	Sand	0	0	2	4	2	9	
26	4	9	Superior	1.5 mi. off Superior Entrance	50	Clay, organ. debris	0	0	5	20	1	1014	Surface DO 10.0 mg/l, Bottom DO 11.3 mg/l.
27	5	9	Superior	3.0 mi. off Superior Entrance	85	Clay	0	0	1	1	0	0	Surface temperature 12°C, Bottom 8°C.
28	13	10	Superior	0.5 mi. southeast of Superior Entrance, 0.5 mi. offshore	30	Sand, clay, organ. debris	1	2	4	30	1	4	
29	14	10	Superior	0.5 mi. southeast of Superior Entrance, 1.5 mi. offshore	65	Silt, clay, organ. debris	1	4	4	4	1	258	
30	15	10	Superior	0.5 mi. southeast of Superior Entrance, 3.0 mi. offshore	85	Silt, sand, clay, organic debris	1	3	2	4	1	345	
31	18	10	Superior	2.5 mi. southeast of Superior Entrance, 0.5 mi. offshore	30	Sand, clay	0	0	1	1	1	1	Water turbid, reddish-brown.
32	17	10	Superior	2.5 mi. southeast of Superior Entrance, 1.5 mi. offshore	50	Hard clay	0	0	0	0	1	1	Very little sample.
33	16	10	Superior	2.5 mi. southeast of Superior Entrance, 3 mi. offshore	70	Clay	1	11	1	5	1	141	
34	8	9	Off Poplar R.	Between Middle R. & Poplar R., 0.5 mi. offshore	30	Sand, clay	1	1	1	1	1	1	Some black sediment.
35	7	9	Off Poplar R.	Between Middle R. and Poplar R., 1.5 mi. offshore	55	Sand, clay, gravel	0	0	3	6	1	1	
36	6	9	Off Poplar R.	Between Middle R. and Poplar R., 3.0 mi. offshore	70	Sand, clay	1	3	1	1	1	2	
37	12	9	Off Bardon Cr.	¼ mi. off Bardon Creek	35								Very turbid.
38	9	9	Off Brule River	0.5 mi. off Brule River	30	Sand, gravel	0	0	1	1	1	1	Water turbid.
39	10	9	Off Brule River	1.5 mi. off Brule River	90	Hard	1	2	0	0	0	0	Very little sample.
40	11	9	Off Brule River	3.0 mi. off Brule River	150	Sand	1	4	1	1	1	5	
41	40	19	Port Wing	0.5 mi. off Port Wing	35	Sand, organic debris	1	1	4	6	2	12	Water turbid, brown.
42	39	19	Port Wing	1.5 mi. off Port Wing	70	Sand, organic debris	1	19	2	1'	1	36	Water turbid, brown.
43	38	19	Port Wing	3.0 mi. off Port Wing	175	Sand, organic debris	1	58	3	10	2	83	Water slightly turbid.
44	36	19	Bark Bay	Middle of bay	70	Sand, organic debris	1	26	2	3	1	12	Water appears green.
45	37	19	Cornucopia	Middle of Siskiwit Bay	45	Sand, organic debris	1	16	4	11	1	22	Water appears green.
46	35	19	Cornucopia	0.5 mi. off Squaw Point	80	Sand, organic debris	1	43	2	4	2	56	Some black sediment.
47	34	19	Cornucopia	1.5 mi. off Squaw Point	110	Clay, organic debris	1	18	1	2	1	9	Gray streaking in clay.
48	33	19	Cornucopia	3.0 mi. off Squaw Point	200	Sand, clay	1	103	2	15	1	57	Some black sediment.
49	70	25	Sand Island	2.0 mi. west of Sand Is.	150	Sand, clay	1	86	1	12	1	90	Water appears slightly green.

TABLE

Permanent Station No.	Field Station No.	July, 1968 Date	Sample Area	Location	Approximate Depth (Ft.)	Bottom	Classification (No./Sq. ft.) Intolerant Spp.	Intolerant No.	Tolerant Spp.	Tolerant No.	Very Tolerant Spp.	Very Tolerant No.	Remarks
50	71	25	Sand Island	6.0 mi. west of Sand Is. Light	300	Clay, cinders	1	1	2	4	0	0	Water appears slightly green.
51	72	25	Sand Island	Between Sand and York Is.	60	Sand, clay	1	77	2	86	2	54	Water appears greenish-brown.
52	73	25	Raspberry Island	Equidistant between York, Raspberry and Bear Island	90	Sand, clay	1	79	3	83	1	7	Water appears green.
53	32	18	Devils Island	1.3 south of Devils Is.	100	Sand, clay	1	60	3	38	1	111	Some black sediment.
54	32N	18	South Twin Is.	1.3 mi. south of South Twin Island	150	Sand, clay, organ. debris	1	88	0	0	2	90	Water very clear. Some black sediment.
55		24	Stockton Island	1 mi. south of Stockton Is.	245								Secchi only.
56	67	24	Red Cliff	Between Red Cliff & Basswood Island	80	Sand, clay, cinders	1	88	2	7	1	15	
57	68	24	Basswood Island	0.5 mi. east of Basswood Island	150	Clay, organic debris	1	30	3	12	1	70	
58	61	23	Bayfield	1.3 mi. southeast of Bayfield	150	Clay, cinders, organ. debris	1	163	3	10	1	1	
59	60	23	Long Island	2.0 mi. east of Long Island Light	80	Sand	1	6	3	5	1	3	
60	48	23	La Pointe	4.5 mi. southwest of La Pointe	70	Clay, organic debris	1	56	4	5	1	25	
61	78,49	23	Chequamegon Bay	11.0 mi. off Fish Creek, center transect	12	Sand, clay, organic debris	3	11	6	36	4	26	
62	50	23	Chequamegon Bay	Between Chequamegon Point & Oak Point	6	Sand	3	5	5	49	3	20	Some weeds.
63	51	23	Chequamegon Bay	1.5 mi. south of Oak Point, 0.5 mi. offshore	7	Sand	2	2	6	71	2	16	Water turbid, brown.
64	52	23	Chequamegon Bay	8.0 mi. off Fish Creek, center transect	15	Sand, gravel	1	3	5	34	4	31	Water slightly turbid. Many mayfly casts on water.
65	53	23	Chequamegon Bay	0.5 mi. south of Houghton Point Bouy.	33	Clay, cinders	1	95	3	5	3	63	
66	34	23	Chequamegon Bay, Washburn	0.5 mi. south of Washburn	20	Sand, clay, organ. debris	2	38	6	247	1	53	Weeds off Washburn boat landing.
67	80,55	23	Chequamegon Bay	5.0 mi. off Fish Creek, center transect	35	Clay, organic debris	2	25	3	10	1	44	Water appears slightly green. Pieces of plastic noted.
68	36	23	Chequamegon Bay, Ashland	0.3 mi. northeast of Ashland Breakwater, 0.5 mi. offshore	10	Clay, organic debris	2	21	6	15	2	92	Some weeds inside breakwater. Pieces of plastic and foil noted. Mayfly casts on water.
69	36A	23	Chequamegon Bay, Ashland	0.5 mi. off American Can Co. towards Ashland Breakwater	15	Clay, organic debris	1	7	6	36	4	933	Pieces of plastic noted.
70	41	22	Chequamegon Bay, Ashland	100 ft. off American Can Co. Outfall	2	Fibers, cinders	0	0	0	0	0	0	Water brown and cloudy. Mayfly casts on water. Pieces of foil and plastic. Bottom almost all fibers. Plastic pieces at boat landing.
71	42	22	Chequamegon Bay, Ashland	300 ft. off American Can Co. Outfall	8	Fibers	0	0	0	0	0	0	Water appears green. DO 8.4 mg/l. Bottom all fibers and odorous. Mayfly casts on water.
72	43	22	Chequamegon Bay, Ashland	0.3 mi. off American Can Co.	14	Bark, pieces of wood	1	2	1	2	1	1	Water appears green. Surface DO 9.2 mg/l. Bottom DO 9.5 mg/l. Mayfly casts on water. Poor sample.
73	57	23	Chequamegon Bay, Ashland	Between ore docks, 0.5 mi. offshore	25	Clay, organic debris	0	0	1	1	2	253	Pieces of plastic noted.

TABLE

Permanent Station No.	Field Station No.	July, 1968 Date	Sample Area	Location	Approximate Depth (Ft.)	Bottom	Classification (No./Sq. ft.) Intolerant Spp.	No.	Tolerant Spp.	No.	Very Tolerant Spp.	No.	Remarks
74	58,38	23	Chequamegon Bay, Ashland	3.0 mi. off Fish Creek, center transect	25	Clay, cinders orgn. debris	0	0	6	17	2	30	Pieces of plastic noted. Water appears green.
75	39	23	Chequamegon Bay	0.5 mi. southeast of Bono Creek	15	Sand, clay, orgn. debris	0	0	7	63	2	12	Pieces of plastic on water.
76	44	22	Chequamegon Bay, Ashland	30 ft. off Ashland STP Outfall	10	Hard, organic debris	1	1	0	0	2	10	Bottom materials black and odorous. Water appears greenish-brown.
77	45	22	Chequamegon Bay, Ashland	Southwest side of Ashland, 0.5 mi. offshore	12	Cinders, clay, gravel	2	9	5	45	2	14	Water appears greenish-brown.
78	105,46	22	Chequamegon Bay, Ashland	1.0 mi. off Fish Creek, center transect	8	Sand, organic debris	3	3	6	52	2	19	Water appears greenish-brown.
79	47	22	Chequamegon Bay	0.2 mi. off Boyd Creek	6	Sand	0	0	6	15	3	12	Some weeds. Water appears deep red.
80	66	24	Oronto Bay	3.0 mi. north of Marble Pt.	80	Sand	1	3	1	1	0	0	Water appears slightly greenish. Some black sediment.
81	64	24	Oronto Bay	0.5 mi. off Saxon Harbor	30	Hard, sand, clay	1	10	1	2	2	6	
82	63	24	Oronto Bay	1.5 mi. off Saxon Harbor	55	Hard, sand, clay	1	1	2	3	1	3	
83	62	24	Oronto Bay	3.0 mi. off Saxon Harbor	70	Sand	1	2	0	0	1	8	
84	65	24	Oronto Bay	0.3 mi. off Montreal River	10	Hard	0	0	0	0	0	0	Water appears brown, but clear. Iron 0.6 mg/l, tannins 0.9 mg/l.
85	5R		Amnicon River	Hwy. 13									Nutrient sample.
86	6R		Brule River	Hwy. 13									Nutrient sample.
87	11R		Pikes Creek	Below RR trestle									Nutrient sample.
88	12R		S. Fish Creek	Hwy. 112									Nutrient sample.
89			Boyd Creek	Hwy. 13			0	0	0	0	0	0	No life present in riffles below DuPont. Water deep red.
90		16	Chequamegon Bay	0.25 mi. off Fish Creek	4								Turbidity only.

Tab. .1
PLANKTON AND TURBIDITY SUMMARY
LAKE SUPERIOR JULY, 1968
PLANKTON TYPE (20 Mesh Net)

Permanent Station No.	Sample Area	Secchi Disc (Feet)	Hach Turbidity J.U.	mg/l Fixed Solids	mg/l Volatile Solids	Zooplankton %				Protozoans %				Diatoms %				Bluegreens %				Greens %				Organic Debris %				Inorg. Debris %			
						1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.
1	St. Louis River	2	8.30	44	71	50	65	37	48	T	10		3	15	9	20	17	T			T	T			T	T			T	25	20	40	28
2	Duluth, Superior Bay	3.5	9.00	30	70	60	70	65	65		10		3	25	15	30	23	15		T	5	T			T			T	T	T	5	5	3
3	Superior Bay	2	7.80	36	31	65	85	65	72					25	10	25	20		T	T	T	T	T	T	T	T	10	T	3	10	5	8	5
4						DO ONLY																											
5	Superior Bay	2	5.30	39	37	60	65	65	63					35	20	30	30	T	5	T	2	T	T	T	T	5		10	5	T	10	5	5
6	[illegible]rior Bay	2	16.00	87	79	65	70	40	58	5	5		3	30	25	30	30									T		10	3	T		15	5
7	Superior Bay	1	27.00	63	57	65	75	50	63					20	10	30	20					T			T	5		5	3	10	10	15	12
8	Duluth	4	4.70	71	68	50	60	45	52	T			T	30	15	35	26									T			T	20	20	20	20
9	Duluth	4.5	8.00	77	67	45	80	45	57					40	20	35	32	T			T					T			T	15		20	12
10	Duluth	7	2.30	98	51	40	60	40	47	T	5		2	60	30	35	42	T			T	T			T	5			2	12	5	1	6
11	Superior	3	2.30	69	184	80	70	80	77					15	25	15	18									T	5	T	2	5	T	5	3
12	Superior	7	1.90			No Plankton Tow																											
13	Superior	5	0.45	73	47	55	55	60	57					30	30	25	28									10	10	10	10	5	5	5	5
14	Superior	13,7	1.10,2.10	60	28	25	20	20	22	T			T	55	60	70	62									10	10	5	8	10	5	5	6
15	Superior	12	0.73	22	19	40	60	40	47	T			T	50	35	35	40			T	T							10	3	10		15	8
16	W. end L. Superior	12	0.70	25	13	5	20	15	13	15		T	5	65	40	60	55									T	20	20	13	15	20	5	13
17	W. end	13	0.98	70	26	35	25	50	37			T	T	20	15	30	22									5	20	45	23	40	40	T	27
18	W. end	Lost	0.65	20	16	50	60	60	57	15			5	30	25	10	22									T	10	20	10	5	5	10	7
19	W. end	Lost	3.00	7	59	100	100	95	98					T		T	T									T		5	2	T		T	T
20	Surf. W. end	Lost	[illegible]	20	16	50	50	35	45	T			T	40	40	35	38										10	30	13	10		T	3
20	100 ft. W. end		0.45																														
21	W. end	Lost	0.55	8	7	40	35	55	43	5			2	35	25	15	25									T		10	3	20	20	20	20
22	Superior	4	2.00	57	77	80	75	75	77					20	15	20	18			T	T			T	T	T	5	T	2	T	5	5	3
23	Superior	3	9.30	70	75	75	75	70	73					20	25	25	23		T	T	T					T	T	T	T	5	T	5	3
24	Superior	2	3.70	47	41	50	45	50	48	T			T	40	40	35	38									5	5	5	5	5	10	10	8
25	Superior	1.5	14.0	106	60	35	55	55	48					35	30	25	30	T		T	T	T			T	10		10	7	20	15	10	15
26	Superior	8	2.30	36	27	60	65	55	60					40	25	30	32					T		T	T	T	5	10	5		5	5	3
27	Superior	8	2.40	36	36	50	40	55	48					45	55	40	47									5				T	5	5	3
28	Superior	4	6.50	101	73	65	45	65	58					25	20	25	23									5	5	10	5	5	30	20	18
29	Superior	4.5	3.00	69	48	65	65	50	60					35	25	45	35	T			T					T				T	10	5	5
30	Superior	5	3.60	65	43	65	60	40	55					30	30	30	30					T			T		5		2	5	5	30	13
31	Superior	3	10.0	36	66	65	80	55	66	T	5		2	35	10	35	27									T	5	5	3	T		5	2
32	Superior	5	4.50	15	71	55	85	60	67	5	10		5	40	5	35	27									T		T	T	T		5	2
33	Superior	5.5	3.00	45	56	60	75	65	67	15	10		8	25	15	35	25					T			T	T							

TABLE 11

Permanent Station No.	Sample Area	Secchi Disc (Feet)	Hach Turbidity S.U.	Mg/l Fixed Solids	Mg/l Volatile Solids	Zooplankton %				Protozoans %				Diatoms %				Bluegreens %				Greens %				Organic Debris %				Inorg. Debris %			
						1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.
34	Off Poplar River	3	16.00	86	60	40	35	40	43					40	30	30	37									5		5	3	15	25	5	15
35	Off Poplar River	7	1.90	78	59	35	60	25	47					40	30	65	45									5		5	2		10	5	5
36	Off Poplar River	8	1.70	18	9	60	80	65	68					35	15	25	25	T			T					5		5	2		5	5	2
37	Off Bardon Cr.	2	22.00			No Plankton Tow																											
38	Off Brule River	3	12.0	103	136	75	85	75	78					25	10	25	20									T	5	T	2			T	T
39	Off Brule River	6	3.00	46	76	75	80	70	75					65	10	15	30	T			T					T			T		10	5	5
40	Off Brule River	9	1.10	28	78	75	75	80	77					25	10	10	15									T			T	T	5	10	5
41	Port Wing	Lost	4.60	40	33	70	78	75	75					20	10	15	15									T		T	T	14	10	10	10
42	Port Wing	Lost	3.70	26	30	80	80	80	80					10	10	15	12									T		T	T	10	10	5	8
43	Port Wing	Lost	1.50	36	21	75	70	75	73	T			T	15	25	20	20									T		T	T	10	5	5	7
44	Bark Bay	Lost	1.60	5	2	30	40	40	37					65	60	55	60			T	T							T	T	5		2	3
45	Cornucopia	Lost	0.72	8	4	45	60	50	52					50	40	45	45									T			T	5		5	5
46	Cornucopia	Lost	1.40	22	10	50	40	46	45																	T	T	T	T	5	5	5	5
47	Cornucopia	Lost	1.10	8	4	25	35	30	30					70	60	65	65											T	T	5	5	5	5
48	Cornucopia	Lost	1.60	6	4	40	50	55	50					30	35	40	37										T	T	T	5	5	5	5
49	Sand Island	12.3	0.76	26	20	55	60	65	60					35	40	20	32			T	T			T	T			5	2	10		15	8
50	Sand Island	14	0.79	11	11	65	75	85	75	T			T	30	25	10	22							T	T			T	T	5		5	3
51	Sand Island	8	2.30	18	10	55	75	40	57			T	T	40	25	40	35					T		T	T					5		15	7
52	Raspberry Is.	10	2.00	25	16	50	70	65	68			T	T	40	15	15	23							T	T					10	20	20	17
53	Devils Island	Lost	0.37	46	26	40	40	45	43					35	50	30	52									T	5	T	2	5	5	5	5
54	South Twin Is.	Lost	0.08	46	21	15	15	20	17					55	55	30	47							T	T	T	10		3	30	20	30	33
55	Red Cliff	12	1.00	37	26	50	30	40	43					55	50	60	55					T		T	T			T	T	5		T	2
57	Basswood Island	20	0.23	8	7	65	55	70	63					30	45	20	32			T	T	T		T	T			T	T	5		10	5
58	Bayfield	13	1.00	107	101	45	30	15	30			T	T	50	70	85	68											T	T	5		T	2
59	Long Island	11	0.75	256	149	5	5	T	3					95	95	95	95					T		T	T	T		3	2			T	T
60	La Pointe	16.5	2.10	128	66	20	15	15	17		5		2	75	90	85	80							T	T			T	T	5		T	2
61	Chequamegon Bay	7	2.30,1.80	986	736	45	25	15	28	T	5	T	2	50	70	80	67					T		T	T			5	2	5		T	2
62	Chequamegon Bay	5	1.80	407	333	45	30	25	33	T			T	40	65	60	55					T		T	T			T	T	15		15	10
63	Chequamegon Bay	2	18.00	288	216	60	35	30	35	5		T	2	30	45	45	40					T		T	T			T	T	5		3	3
64	Chequamegon Bay	7	3.10	1066	1124	35	60	50	48	T		T	T	45	60	50	52							T	T	T		T	T				
65	Chequamegon Bay	13	0.61	318	211	55	30	40	42					40	70	60	57							T	T	T		T	T	5		T	2
66	Chequamegon Bay, Washburn	9	1.30	296	169	35	30	30	32	T		T	T	45	80	80	68							T	T	T		T	T			T	T
67	Chequamegon Bay, Washburn	6	233.30	441	368	60	40	20	40	T			T	40	50	80	60					T		T	T			T	T	T		T	Tr
68	Chequamegon Bay, Ashland	3	8.00	371	386	35	25	30	37	T		T	T	65	75	80	73							T	T			T	T	T		T	
70	Chequamegon Bay Ashland	1	36.00	253	726	15	10	10	12					10		5	5									65	80	75	73	10	10	18	15

TABLE

Permanent Station No.	Sample Area	Secchi Disc (Feet)	Hach Turbidity S.U.	Mg/l Fixed Solids	Mg/l Volatile Solids	Zooplankton %				Protozoans %				Diatoms %				Bluegreens %				Greens %				Organic Debris %				Inorg. Debris %			
						1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.	1	2	3	Av.
71	Chequamegon Bay, Ashland	11,4	1.60	97	72	20	20	25	22					70	70	70	70									5	10	5	7	T		T	T
72	Chequamegon Bay, Ashland	4	2.50	558	390	50	40	45	45					50	60	50	53									T		5	2	T		T	T
73	Chequamegon Bay, Ashland	5	3.20	264	264	60	70	60	63	5			2	35	30	40	35											T	T	T		T	T
74	Chequamegon Bay, Ashland	7	11.0,2.60	365	233	40	20	20	27	5		T	2	55	80	80	72					T		T	T			T	T	T		T	T
75	Chequamegon Bay	8.5	1.40	189	192	70	35	85	63					30	65	15	37							T	T							T	T
76	Chequamegon Bay, Ashland	3.5	5.00	559	323	35	25	25	28	5			2	50	75	65	63									T		T	T	10		10	7
77	Chequamegon Bay, Ashland	3.5	5.50	596	322	40	20	35	32	T			T	55	80	65	67							T	T	T		T	T	5		T	2
78	Chequamegon Bay, Ashland	5	8.0,2.30	242	149	50	55	45	50					45	45	60	50							T	T					5			2
79	Chequamegon Bay	3.5	2.70	1319	878	60	50	40	50	T			T	35	45	55	45							T	T	T	T	T	T	5	5	5	5
80	Oronto Bay	16	0.58	54	45	15	15	5	12					80	85	95	87			T	T	5		T	2			T	T	T		T	T
81	Oronto Bay	15	0.65	62	33	15	5	5	8					80	95	90	88			T	T			T	T			T	T	5		5	3
82	Oronto Bay	17	0.26	128	62	5		T	2		5	T	2	90	95	95	93			T	T			T	T	T	T	T	T	5		5	3
83	Oronto Bay	18	0.32	181	90	25	10	5	13					85	90	95	90			T	T	T		T	T	T		[illegible]	T	T		T	T
84	Oronto Bay	11	0.85	301	128	30	15	20	22	10	10	10	10	40	75	60	58							T	T			10	[illegible]	20		T	7
85	Amnicon River		30.00																														
86	Brule River		18.00																														
87	Pikes Creek		16.00																														
88	S. Fish Creek		60.00																														
89	Boyd Creek																																
90	Chequamegon Bay		44.00																														

TABLE III
NUTRIENT AND VOLATILE SOLIDS SUMMARY
LAKE SUPERIOR, JULY, 1968

Permanent Station No.	Sample Area	Total Organic	PPM Nitrogen as Free NH_3	NO_2	NO_3	Total Inorganic	PPM Phosphorus as Sol.P	Tot.P	µ~~m~~g/1 Fixed Solids	µ~~m~~g/1 Volatile Solids
1	St. Louis R. Upstream from High Bridge	0.98	0.34	0.012	0.41	0.76	0.057	0.112	44	71
2	Inside Duluth Entrance	0.90	0.17	0.010	0.37	0.55	0.028	0.108	30	70
6	0.5 mi. west of Sky Harbor Airport	0.83	0.21	0.040	0.49	0.74	0.058	0.110	87	79
7	Inside Superior Entrance	0.89	0.24	0.014	0.49	0.74	0.042	0.106	63	57
12	1.0 mi. off Superior Bay center transect	0.27	0.08	0.002	0.26	0.34	0.011	0.035	73*	47*
14	3.0 mi. off Superior Bay center transect	0.18	0.05	0.002	0.26	0.312	0.007	0.022	69	26
15	5.0 mi. off Superior Bay center transect	0.14	0.04	0.002	0.26	0.302	0.008	0.020	22	19
16	10 mi. off Superior Bay center transect	0.13	0.04	0.002	0.24	0.282	0.007	0.020	25	13
17	15 mi. off Superior Bay center transect	0.13	0.04	0.002	0.24	0.282	0.006	0.020	70	24
18	25 mi. off Superior Bay center transect	0.14	0.05	0.002	0.24	0.292	0.008	0.020	20	16
19	40 mi. off Superior Bay center transect	0.17	0.02	0.002	0.24	0.282	0.009	0.028	7	59

TAB. III

Permanent Station No.	Sample Area	Total Organic	PPM Nitrogen as Free NH$_3$	NO$_2$	NO$_3$	Total Inorganic	PPM Phosphorus as Sol.P	Tot.P	μ~~M~~g/1 Fixed Solids	μ~~M~~g/1 Volatile Solids
20	55 mi. off Superior Bay center transect	0.14	0.02	0.002	0.22	0.242	0.006	0.020	20	14
21	70 mi. off Superior Bay center transect	0.14	0.06	0.002	0.22	0.282	0.008	0.014	8	7
54	1.3 mi. south of South Twin Island	0.10	0.02	0.002	0.22	0.242	0.007	0.018	46	21
61	Chequamegon Bay 11 mi. off Fish Creek center transect	0.19	0.05	0.003	0.24	0.293	0.004	0.016	904	734
67	Chequamegon Bay 5 mi. off Fish Creek center transect	0.25	0.05	0.012	0.36	0.422	0.05	0.076	441	268
74	Chequamegon Bay 3 mi. off Fish Creek center transect	0.26	0.05	0.010	0.36	0.420	0.012	0.17	365	233
78	Chequamegon Bay 1 mi. off Fish Creek center transect	0.23	0.12	0.006	0.32	0.446	0.008	0.04	242	149
85	Amnicon River, Hwy. 13	0.88	0.12	0.005	0.29	0.415	0.005	0.06		
86	Brule River, Hwy. 13	0.72	0.10	0.002	0.17	0.272	0.042	Turbid		
87	Pikes Creek Below RR trestle	0.35	0.10	0.007	0.24	0.347	0.031	0.05		
88	S. Branch Fish Creek Hwy. 112	1.07	0.14	0.006	0.34	0.486	0.097	0.11		

* Plankton sample at 1.5 mi. off Superior Bay, Station 13

TABLE IV
CLADOPHORA GROWTHS
LAKE SUPERIOR, JULY, 1968

Nearest Permanent Station Numbers	Location	Extent	Remarks
44	Bark Bay	Light	
44,45	Point between Bark Bay and Siskiwit Bay	Moderate	
46	Squaw Point	Moderate	6 inch strip on rocks at water line.
51	Sand Island, east of light	Moderate	
51	York Island, northwest point	Moderate	
52	Raspberry Island, at light	Light	
52	Raspberry Island, east of light	None	
52	Raspberry Island, southeast side	Light	1 inch strip
52	Raspberry Island, east side	Trace	
52	Bear Island, southwest side	Light	
55	Oak Island, south and southeast sides	Trace	
55	Stockton Island, south and southwest sides	None	
55	Hermit Island, east side	Light	
56	Roys Point, on mainland	Light	
56	Basswood Island, west side	None	
57	Basswood Island, east side	None - Trace	

TABLE V

Nearest Permanent Station Numbers	Location	Extent	Remarks
58	Bayfield Harbor area	Moderate	
58	Madeline Island, La Pointe	Moderate - Heavy	
58	Madeline Island, 1 mi. north of La Pointe	Light	
58	Madeline Island, 2 mi. northeast of La Pointe	None	
59,60	Madeline Island at S. Channel	None	
68	Ashland breakwater	Moderate	
80	Marble Point	None	
81	Montreal River mouth	Moderate	
84	1 mi. northeast of Montreal R.	Moderate	

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The following is a narrative description of the status of each of Wisconsin waste sources within the Lake Superior Basin.

Superior Fiber Products, Inc., was ordered to construct adequate process wastewater treatment facilities individually or jointly with the city per approved plans by October 1, 1970. Also, the mill sanitary sewage must be connected to the municipal sewers by June 30, 1969, or adequate sewage treatment facilities must be provided by that date. The mill is working with the city on a joint solution and has retained a consulting engineer.

The city of Superior was ordered to construct adequate waste treatment facilities per approved plans by October 1, 1970, and submit schedule by June 30, 1968. Also, the city is to develop a program for storm and sanitary separation or construct facilities for adequate treatment of both wastes and waters tributary to sewer system by October 1, 1970.

Bodin Fisheries was ordered to provide adequate treatment of wastewater or connect to the municipal system by October 31, 1968. Sanitary wastes have been connected to the city and the company has requested a time extension for industrial wastes.

The city of Bayfield was ordered to construct adequate sewage treatment facilities by October 1, 1970, and to develop a program for clear water exclusion or construct facilities for adequate treatment of both wastes and waters tributary to the system by October 1, 1970. The city has retained a consulting engineer.

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The Pure Air Sanitorium was ordered to provide adequate sewage treatment facilities by October 31, 1968. It has retained a consulting engineer.

The city of Washburn was ordered to construct adequate treatment facilities by October 1, 1970, and to develop a program for clear water exclusion or provide for both clear water and waste treatment by October 1, 1970. The city has retained a consulting engineer.

The Lake Superior District Power Company operates a relatively small, fossil-fueled plant for generating electricity at Ashland. The condenser cooling water from this plant was not found to have an adverse effect on the receiving waters.

The city of Ashland was ordered to construct adequate sewage treatment facilities by October 1, 1970, and to develop plans for storm and sanitary sewage separation or construct treatment facilities for both clear water and wastewater by October 1, 1970. Preliminary plans were submitted on March 31, 1969.

The American Can Company, Ashland Division, was ordered to provide adequate process wastewater treatment or connect with the city by October 1, 1970. It has installed a clarifier and a centrifuge and process changes have resulted in no plastic film reaching the lake.

The Union Tank Car Company, Superior, has installed a septic tank and seepage pit for sanitary wastes and there is no overflow to surface waters.

Francis H. Schraufnagel

The village of Superior has adequate waste treatment facilities.

The Great Northern Railway now has no overflow from its industrial waste lagoons.

The Soo Line Railway yards at Superior connected its wastes to the municipal system.

The Murphy Oil Company was ordered to provide adequate waste treatment facilities by October 31, 1970.

There is no overflow from waste facilities at Koppers Company, Inc.

The Great Northern Railroad, Allouez, outside of Superior, was ordered to provide adequate sewage treatment facilities. It is expected that the facilities will be completed in July 1969.

The Douglas County Hospital and Sanitorium waste treatment facilities provide adequate treatment.

The Middle River Sanitorium and Douglas County General Hospital have adequate waste treatment facilities.

Iron River was ordered to construct adequate waste treatment facilities by October 31, 1969, and to develop plans for clear water exclusion or provide adequate treatment of clear water and wastes by October 31, 1969. A consulting engineer has been retained.

Fuhrmann's South Shore Dairy have installed a holding tank and factory wastes are being hauled.

Port Wing has installed a new sewage collection system and a stabilization lagoon. This facility also serves Everett Fisheries.

Martin's Dairy have submitted plans for hauling wastes for approval and intend to initiate the program this spring.

The E. I. du Pont de Nemours and Company has submitted a time schedule, which was approved, with a completion date of September 1, 1970, for waste treatment facilities.

The Ondossagon School was ordered to construct adequate sewage treatment facilities by September 1, 1969. A consulting engineer has been retained.

The Moquah Cheese Factory hauls wastes and there is no discharge to surface waters.

The Twin Ports Dairy, near Moquah, was ordered to provide adequate waste treatment facilities by October 31, 1968. Facilitites have been provided for sanitary wastes and the dairy plans to separate clear water from process wastewaters for containment of the wastes.

The Andersonville Co-op Dairy, outside of Ashland, was ordered to provide adequate waste treatment facilities. Upon arrival of a holding tank, all wastes will be hauled to a sand pit.

The city of Mellen was ordered to provide adequate sewage treatment facilities by October 1, 1970, and to develop a clear water exclusion program by December 31, 1968. The city adopted an ordinance on September 3, 1968, to eliminate surface water to the sanitary system.

St. Mary's Indian School is closed.

The town of Knight, known as Unincorporated Village of Iron Belt, was ordered to construct adequate treatment facilties by October 31, 1969, and to develop plans for clear water exclusion or construct facilities for treatment of both clear water and wastes by October 31, 1969. The town has retained a consulting engineer.

The community of Saxon was ordered to provide adequate sewage treatment facilities by October 31, 1969. Also, Saxon was ordered to develop a program for clear water exclusion or construct adequate treatment of both clear water and wastes by October 31, 1969.

Mason Milk Products discharges wastes to a septic tank which overflows to a lagoon. There is no evidence that wastes reach surface waters.

The city of Hurley was ordered to construct adequate sewage treatment facilities by October 1, 1970. Also, Hurley was ordered to develop a clear water exclusion program or to construct adequate treatment facilities for both clear water and wastes by October 1, 1970. The city has retained a consulting engineer and initiated studies on clear water.

The city of Montreal was ordered to construct adequate sewage treatment facilities and also to develop a clear water exclusion program or to construct facilitities for adequate treatment of both clear water and wastes by October 1, 1970.

The community of Pence was ordered to construct adequate sewage treatment facilities by October 31, 1969.

In conclusion, it is apparent that Wisconsin has, for a considerable period of time, recognized the unique character of Lake Superior and the need to maintain and preserve its present high quality. The interstate water quality standards adopted for Lake Superior and approved by the Secretary of the Department of the Interior require the highest standards for Lake Superior open waters and provide for all uses, including that for public water supply. As a follow-up to setting interstate standards, standards for intrastate waters have been established for the remaining water courses in the drainage basin.

Localized pollution problems have been identified and enforcement action has been taken to abate unsatisfactory conditions. Compliance with orders that have been issued by the Department of Natural Resources should result in attainment of water quality that meets established standards.

We are pleased to participate in these conference proceedings in an effort to ascertain the extent of harmful effects of waste discharges. We desire to examine all technical data and evidence that is available and are committed to embark on any appropriate action that is warranted.

That completes my statement.

(Applause.)

MR. STEIN: Are there any comments or questions?

Mr. Badalich.

MR. BADALICH: I have one question for either Mr. Schraufnagel or Mr. Frangos.

In your report you refer to adequate treatment facilities or adequate process treatment. Does this imply it is primary or secondary? What is your definition of "adequate"?

MR. SCHRAUFNAGEL: Treatment comparable to secondary facilities is provided or, in some cases, land disposal, which probably is not considered as a treatment but is a disposal being used.

MR. BADALICH: But the treatment process will meet your water quality standards?

MR. SCHRAUFNAGEL: Yes.

MR. STEIN: On Page 3 you talk about the Bodin Fisheries. How much is the requested time extension for its industrial waste? It was supposed to have it cleaned up by October 31, 1968. What is that extension?

MR. SCHRAUFNAGEL: I don't have that information with me.

MR. STEIN: In other words, I wonder if you could supply this for the record, because this is one of the cases we don't have a cutoff date when these people are supposed to be finished.

MR. SCHRAUFNAGEL: That can be supplied.

MR. STEIN: I have one more point. I just picked this out, and a lot of them are this way. You have, "The Pure Air Sanitorium was ordered to provide adequate sewage treatment facilities by October 31, 1968. It has retained a consulting engineer." In other words, Pure Air, that sanitorium, the works were not in by October 1968, and for more than a year, we are behind on that now, and they just have a consulting engineer, is that correct?

MR. SCHRAUFNAGEL: That is correct.

MR. STEIN: With these dates, again we don't have a cutoff date. I guess the Pure Air Sanitorium isn't doing its part in providing pure water.

MR. SCHRAUFNAGEL: There are a number of municipalities in here that have one consulting engineer.

MR. STEIN: What I am saying - I just picked this one out - I think if you will look through your testimony you will find there are a lot of dates which have gone past or which probably cannot be met, and they have just hired a consulting engineer and not started construction. I wonder if this list could be gone through again so that the conferees could have a realistic notion of when they could expect a completion of work, because that is presumably what we will get from the statement.

MR. SCHRAUFNAGEL: I think most of this is in the appended material. Most of the time it is in 1970. It is more or less a matter of progress.

MR. STEIN: If that is in the report, that is fine.

Yes, I would like to say there is a table in the back which presumably gives it. Thank you.

MR. SCHRAUFNAGEL: That is correct.

MR. PURDY: Mr. Chairman, I am wondering if the municipalities and industries listed in the report represent all municipalities and industries within the Lake Superior Basin. There are only the industries in the State of Wisconsin considered.

MR. SCHRAUFNAGEL: These are both intrastate and interstate waters and potential pollution.

MR. PURDY: They represent all the municipalities and industries within the Lake Superior drainage basin?

MR. SCHRAUFNAGEL: That is correct.

MR. PURDY: Thank you.

MR. STEIN: Are there any further comments or questions?

(No response.)

MR. STEIN: Thank you very much.

Mr. Frangos.

MR. FRANGOS: I think it would be appropriate at this time for me to make a short comment about the Reserve Mining situation.

Under existing State statutes and present State policy, other operations similar to the Reserve Mining operations will not be permitted to be installed in Wisconsin. In view of this, Wisconsin has submitted an objection to present practices at Silver Bay in the matter that is before the U. S. Army Corps of Engineers raising the question of potential pollution.

Now having stated this, I should comment on these proceedings that we are participating in today.

T. G. Frangos

As has been pointed out on several occasions, this conference is a legal proceeding, therefore, we must make some specific technical findings for Federal jurisdiction to apply. Up until very recently we have not had information that would indicate to us that taconite tailings are causing interstate pollution. The FWPCA report indicates that this may be occurring. Since receiving the report - and I refer to the white document - at this conference we have received more detailed information from the FWPCA which, 1) supports many of the statements which appear in the report; 2) additionally, some information has been made available to us that indicates more information as a result of surveys that were conducted subsequent to the time that the report was prepared and issued.

We are impressed by the confidence of the Federal scientists. We also have a high regard for the consultants retained by Reserve Mining. This morning we received an equally impressive volume of reports and studies from the company. We have not had a chance to digest all of this information. But from what we have been able to read and what we have heard, it would appear that some different conclusions have been reached. At this point what we want to say is that we want to take a look at all this new data and make whatever judgements we can make from them. Let me assure all the conferees that we are committed to insisting that whatever action is deemed necessary will be taken to abate whatever pollution may be occurring.

That concludes my statement.

MR. STEIN: Do you have any more witnesses to call?

MR. FRANGOS: Yes.

MR. STEIN: Would you go ahead.

I don't want to foreclose comments or questions, if there are any.

(No response.)

MR. STEIN: Would you continue, Mr. Frangos.

MR. FRANGOS: Mr. Chairman, We have received a communiciation from the Honorable John F. Wroblewski, Mayor of the city of Washburn. He has asked me to read his statement into the record.

Mr. Thomas G. Frangos, Department of Natural Resources,
Box 450, Madison, Wisconsin

Dear Sir:

I wish that the following statement be made part of of the record for the above hearing.

Our City of Washburn, which is located on Chequamegon Bay on Lake Superior is at the present time getting its water supply from the lake.

The quality of the water has fast been deteriorating and has gotten to a point that the State of Wisconsin Board of Health has recommended through Mr. Gene Kelly that the city change its source of water supply. It was presented to the people on a referendum basis and was wholeheartedly passed. We are now in the process of drilling wells.

This proves to me that the public in our city is aware of the ever-increasing problem of the deterioration of the quality of our water in this part of Lake Superior. To make it biologically safe at the present time, we must heavily chlorinate it to an extent that it is very distasteful. We all can remember Lake Superior as a beautiful, cold, clear, blue lake and we certainly cannot see it that way today as it is very cloudy at times.

Just at a time when our city is beginning to feel the impact of the tourist and recreation industry, we are faced with the deterioration of Lake Superior. A lake which belongs to every person in this country to use and to enjoy.

Our city is also under order to provide a secondary waste disposal system, and we will do our utmost to provide it.

Therefore, let me close by stating that if Lake Superior is to be saved it must be done by everyone who uses it, whether it be a city, industry, or the State or Federal Governments. A standard for the quality of the water must be set very high by both the Federal and State Governments. Only when this is done can we look to a good future for Lake Superior. Thank you.

Very truly yours, John F. Wroblewski, Mayor, City of Washburn, Wisconsin.

MR. STEIN: Thank you.

Would you continue, Mr. Frangos.

T. G. Frangos

MR. FRANGOS: I have a statement received from the Douglas County Board of Supervisors.

MR. PURDY: Mr. Chairman, I would like to ask Mr. Frangos if he would like to comment on the statement of the Mayor as to the reason for the deterioration of the lake and why the Health Department made the recommendation that they seek a new source of water supply.

MR. FRANGOS: In response to the question, we have not been able to discern any real change in water quality in the Washburn area. This situation goes back some 35 years. The community at that time and up until very recently was taking water from the lake and applying chlorination. So, the insistence of the Board of Health was to either provide filtration, which, as you know is a good practice, to give us the multiple preventive barrier that we talk about or else go to an alternative source. Our understanding of the situation is that the city chose to go through the alternative source for a number of technical and economical reasons.

MR. PURDY: So you are not confirming the comments that it has been deteriorating?

MR. FRANGOS: We don't have information that indicates that to us.

MR. PURDY: Thank you.

MR. STEIN: Are there any further comments or questions?

(No response.)

Douglas County Board of Supervisors

MR. STEIN: If not, Mr. Frangos.

MR. FRANGOS: I have a statement from the Douglas County Board of Supervisors.

To Whom it May Concern:

A statement by representatives of the Douglas County Board of Supervisors concerning the pollution of Lake Superior and streams that feed into Lake Superior. The Douglas County Board of Supervisors has always been vitally concerned about any pollution problems that now exist or the potential of any new pollutants that may enter Lake Superior. We know that Lake Superior has a quality of water that surpasses all other major lakes of the United States, and we, as a Board of Supervisors representing thousands of people, aim to do our part in promoting any enforceable legislation dealing with antipollution of Lake Superior or the streams entering into it, and we do hereby wish to state that we concur generally with the recommendations for the preserving of the high quality of waters of Lake Superior as stated by the United States Department of Interior, Federal Water Pollution Control Administration and we, as one of the many municipalities involved in antipollution measures, pledge our support to any regulatory action necessary to prevent pollution from any source in order to maintain Lake Superior as one of the greatest fresh water bodies of the earth.

MR. STEIN: Are there any questions or comments?

(No response.)

Five County Development Group

MR. STEIN: If not, Mr. Frangos.

MR. FRANGOS: We have a statement received from the Five County Development Group in the form of a letter, which reads:

Dear Mr. Frangos:

The Five County Development Group, which consists of a development committee from Ashland, Bayfield, Iron, Douglas, and Price County Boards, voted to strongly support the Federal Water Pollution Enforcement Conference on Lake Superior at the group's April 24, 1969, meeting.

The group felt that it would take the strong arm of the Federal Government to enforce the law and make sure that each State complies.

As it is today, States competing for industry can allow a company economic advantage by allowing their wastes to be released into Lake Superior. An example of this is the 60,000 tons of taconite tailings being released daily into Lake Superior by Reserve Mining Company, Silver Bay, Minnesota.

Wisconsin laws require that any taconite operation have settling ponds and reuse of wastewater. Minnesota has allowed the mining companies to get away with murder. Let's make it even for all and stop this unnecessary pollution by Reserve Mining Company. Lake Superior is the finest and cleanest of our Great Lakes, and it should be protected now by enforcing the law. It is easier to prevent pollution in the first place.

Yours truly,

Tom LaBlonde,

Secretary, Five County Development Group

MR. STEIN: Are there any comments or questions?

(No response.)

MR. STEIN: If not, will you go on, Mr. Frangos.

MR. FRANGOS: At this time I would call upon representatives of the American Can Company, Ashland, Wisconsin, to make a statement.

STATEMENT OF VICTOR SCHMIDT,
MILL MANAGER, AMERICAN CAN
COMPANY, ASHLAND, WISCONSIN

MR. SCHMIDT: Mr. Chairman, conferees, ladies and gentlemen:

My name is Victor Schmidt. I am the mill manager of the American Can Company mill located in Ashland, Wisconsin. Among my duties I have the responsibility for the company program in the abatement of water pollution at this plant.

The Ashland Paper Mill employs 250 people. Its two paper machines produce 60 tons of tissue per day and all of this is converted into napkins at this plant. The raw material for producing this tissue stock consists of waste papers, either originating in other company plants or purchased from outside sources.

The waste papers are a mixture of brokes coming from converting plants which produce paper milk containers, cups, or food packages. It may be printed or unprinted, laminated with foil or plastic, or simply trim and cuttings. All of this is processed at Ashland to remove ink, wax, foil and plastic After these materials are removed, the basic fibre is bleached and washed in preparation for use on the paper machines.

The extraneous materials removed from the raw brokes amount to about 15 dry tons per day. Somewhat over half of this consists of foil and plastic. These materials are screened out of the broke, dewatered, and conveyed to the boiler plant for disposition by burning. The remaining waste, as suspended solids, is settled out in two clarifiers and the sludge dewatered by centrifuging. The treated effluent is reused in the mill and the excess discharged to the lake.

Approximately 2 million gallons of freshwater are used daily. This is pumped from the lake, filtered and clarified, and used mostly on the paper machines. The white water from the paper machines is used as make-up water in the fibre recovery plant. Thus, the latter acts as a recovery system for paper mill white water as well as for reclaiming the fibrous raw material.

The wastewater processing equipment installed and operating consists of a 40-foot clarifier, a 70-foot clarifier, a press to dewater the plastic to permit burning, and a centrifuge to dewater the clarifier sludge.

Capital expenditures the past few years for this equipment have been well over $350,000 and current operating expenses are over $40,000 annually and we are still actively pursuing every method which will further improve the pollution abatement operations.

In conclusion, I would like to emphasize that the American Can Company recognizes its obligation as a citizen of the communities in which its plants are located and intends to continue its policy of cooperation with regulatory authorities toward improving stream conditions.

Thank you.

(Applause.)

MR. STEIN: Just a moment, sir.

Are there any comments or questions?

(No response.)

MR. STEIN: Do you expect to comply with the requirements of Wisconsin so far as treatment facilities go?

MR. SCHMIDT: Yes.

MR. STEIN: What are you going to do?

MR. SCHMIDT: We have to improve the operation - the effluent operation that we are now currently operating.

MR. STEIN: Obviously, with the amount of water you have taken in you don't have the full system and you have that bleach water going out, bleach and wash and bleach and wash?

MR. SCHMIDT: Yes. It is not a pulp mill.

MR. STEIN: I know it is not a pulp mill. But, nevertheless, dealing with water such as we have up here, when you have a bleach and wash operation it is quite a bit of material.

MR. SCHMIDT: Yes.

MR. STEIN: Are there any other comments or questions?

(No response.)

MR. STEIN: If not, thank you very much.

MR. BLATNIK: Mr. Chairman, could I raise one question? I think it would be pertinent, not only to the whole hearing but also from the Wisconsin aspect.

MR. DOMINICK: Please do. We would like to hear from Congressman Blatnik at this time.

MR. BLATNIK: Mr. Chairman, conferees, ladies and gentlemen of the audience:

Mr. Chairman, some question, and I think a quite justifiable and serious question, has been raised during this conference about the existence of additional information on the existence of cummingtonite obtained by the Federal Water Quality Laboratory which they obtained from the Wisconsin side of the lake in Superior, and I do respectfully request, Mr. Chairman, to have the proper official of the water laboratory make this information public for the record of this conference.

MR. DOMINICK: Thank you, Congressman Blatnik.

We would be happy to hear from Dr. Mount, who is the

Director of the National Water Quality Laboratory, in order that the air might be cleared of the misunderstandings which were mentioned on the point of FWPCA's continuing investigations on the subject of Lake Superior water quality. Consistent with my statement of this morning, I would point out that the discussion we will have from Dr. Mount will deal with water samples recently obtained by FWPCA personnel, and that these samples have not been fully analyzed or evaluated, and, therefore, are not presented to the conference as conclusive or as subject to consideration by the conference at this time. The purpose of discussing these invesitgations at this time is to make clear to all that you have expressed an interest and, as you say, a very legitimate interest, in the investigations that are being carried forward and will continue to be carried forward by FWPCA personnel.

Dr. Mount, we would be happy to have a discussion from you of the water samples in question.

MR. BLATNIK: Thank you very much, Mr. Chairman

(Applause.)

Donald I. Mount

STATEMENT OF DONALD I. MOUNT, DIRECTOR, NATIONAL WATER QUALITY LABORATORY, DULUTH, MINNESOTA

DR. MOUNT: Mr. Chairman, you will have to bear with me a little bit on this because this data is on a lot of sheets.

I think it would be appropriate before I discuss specifically these samples of the question at least to review a few points that one must go through in an attempt to use a tracer to identify and kind of waste. Actually, much of the work, or rather much of the data that I presented, Mr. Andrew presented, yesterday has been worked out since last September, and a great deal of thought, a great deal of work has gone into it and an awful lot of things that we tried didn't work. In fact, more things didn't work than did, so is the case, I guess.

The first question we were faced with was to find a unique tracer, if there was one, for tailings. Now, it is obvious that it would be silly to use something like iron to trace tailings, because the stream sediments are high in that content, as are most of the natural substances. We would rule out certain things on obvious grounds. The use of cummingtonite as a tracer was really a happenstance. It happened one day when I was discussing with our chemist how we were going to identify some crystals that were on a filter pad, and Mr. Andrew said, "Let's look at that by X-ray infraction." He said, "There is a very unusual mineral in this sample," he said, "grunerite," and we found out it was cummingtonite. Our next job was to search the basin to see if this was really unique to this source or if we had to go further. Somewhere during this period the report of the State of Minnesota was called to my attention and this was given further encouragement that it was useful.

We spent most of February and March looking along the stream along the North Shore for the sources of cummingtonite other than Reserve sources, and, as I stated yesterday, we didn't find any. And then finally we looked at the water supply. I mention this again to point out that there is a great deal more work involved than just the identification of cummingtonite alone.

On May 5 and 6 we arranged with the Fish and Wildlife Service at Ashland to take us on a sample-collecting trip at the end of Lake Superior. We chose two transects, one extending from Silver Bay to Sand Island, which is across the end of the small part of the bay, and another transect from Encampment Island to Herbster, Wisconsin. These two transects were picked primarily based on the hydroelectrical data on the lake. These samples were taken from different mile intervals from the State boundaries. The first one was received on Monday, May 5, about 9 o'clock in the evening, and processing was begun the next day.

Donald I. Mount

I should mention that the samples - we are not dealing here with water samples but with sediment samples - water samples were taken and have not been analyzed.

The sediment samples were collected in as undisturbed a fashion as possible and the surface was removed to get at the most recent sediments that were contained in the samples. These were refracted by analysis. These are the tracings that I have in front of me.

On the most easternmost transect, the one extending from Silver Bay to Sand Island, we found what we would have to call traces of cummingtonite on that transect. One of them was essentially negative. On the transect extending from Encampment Island to Herbster, there was considerably more cummingtonite, enough to say that it was definitely present.

This is the state of our present analyses, and remaining yet we have to find out whether cummingtonite is present in the deeper sediments so we know whether this is being added as a recent addition or whether it has been coming in for years and years.

Secondly, we must look at the other potential sources of cummingtonite in Wisconsin and probably, based on the present knowledge of lake currents, even in Michigan, before we can begin to make any statements about - to say it in a different way - what source this cummingtonite is coming from.

Does that suffice?

MR. DOMINICK: Thank you very much, Dr. Mount.

I think that that puts everyone's mind at ease and clears the record here for the conference as we continue.

Mr. Frangos?

MR. FRANGOS: Yes.

I would now like to have the representatives from the E. I. du Pont de Nemours Company make a statement on behalf of the company.

There will be two people making the presentation, and I would suggest to the conferees that they defer any questions until both presentations are concluded.

STATEMENT OF JOHN G. BLACKBURN, MANAGER, E. I. DU PONT DE NEMOURS AND COMPANY, BARKSDALE, WISCONSIN

MR. BLACKBURN: Mr. Chairman, Mr. Frangos, conferees:

My name is John G. Blackburn. I am manager of the Du Pont Company's plant at Barksdale, near Ashland, Wisconsin. I am a resident of Washburn, Wisconsin.

We appreciate the opporutnity given us to appear here to tell the conferees and members of the public about our efforts to meet the water quality standards for Lake Superior which have been adopted by the State of Wisconsin and approved by the Secretary of the Interior.

Our plant at Barksdale produces several explosive products based primarily on trinitrotoluene, or TNT. Our plant is the only one in the United States that makes TNT for commercial sale. We have produced TNT in varying amounts at Barksdale for over 50 years, since World War I. At times the quantities produced have been at several times the present rate. Our plant presently employs about 300 people.

In the production of TNT wastewaters are produced. The principal waste is what is called "red water" because of its color. Incidentally, the term "red water" is used in the FWPCA Lake Superior report in reference to certain open iron ore pit wastes which are turbid and high in suspended solids. TNT "red water" is entirely different and has no suspended solids. "Red water" from our process area now enters Chequamegon Bay after flowing down Boyd's Creek, a tributary to the bay. A coloration of the shallow near-shore waters occurs in a small part of the southwest corner of the bay. As a result, "red water" constitutes an aesthetic problem in that area.

However, based on extensive laboratory tests and on practical experience, "red water" constitutes pollution only in the aesthetic sense. After dilution, "red water" does not affect the character and quality of the receiving waters. In other words, these waters are suitable for any other beneficial use.

Extensive tests by Du Pont and governmental agencies were made to determine the effects of "red water" from a pollution point of view. It was found to be nontoxic to warm-blooded animals in numerous tests which have been documented to the Wisconsin Board of Health. To our knowledge these wastes were disposed of without treatment during World War II to several water courses in other parts of our country which served large populations as potable supplies - without adverse effects. These plants were built and operated for the United States Government.

Our own plant drinking water is withdrawn from Chequamegon Bay about 900 feet from the mouth of Boyd's Creek. Deer and other wildlife within our plant's fenced-in area have thrived despite their having no other significant source of drinking water than that in Boyd's Creek. In fact, the Wisconsin game agencies have, from time to time, trapped up to 400 deer within our plant boundaries for stocking in other parts of the country, some in Florida. We have even opened up our plant area for bow-and-arrow hunting during the appropriate season. In 1960, for example, at least 136 deer were so killed.

Our wastes are not harmful to wildlife, including fish, after dilution in the waters of Chequamegon Bay. Whatever complaints have been made about our "red water" have been because of its color. In the 50 years we have been here we are unaware of any instance of fish-kills or effects on the fishery resources of Chequamegon Bay. In fact, the smelt fishery is excellent in the bay. During this year's run, for example, there were so many people fishing for them that the road along the bay near the plant was blocked off to one lane by the fishermen's cars.

John G. Blackburn

On April 26, 1967, the Wisconsin Resources Development Board adopted water quality criteria and a plan for implementation for the interstate waters of Wisconsin. These were submitted to the Secretary of the Interior by the Governor and accepted by the Secretary.

In regard to colored wastes, the Wisconsin criteria state that "Materials producing color ... shall not be present in such amounts as to create a nuisance." The standards further state that the Du Pont plant at Barksdale will require "adequate treatment or disposal" by October 1, 1970.

We plan to provide adequate disposal to eliminate the color problem which now exists along the shoreline of Chequamegon Bay. We shall, thereby, meet the requirements of the standards to eliminate conditions which some might now consider to be an aesthetic nuisance.

I have asked Lloyd L. Falk of our Engineering Department to present a summary of our efforts to date and outline our proposal to eliminate this colored bay water situation.

But before I leave, let me point out that, as you conferees know, the task of developing a rational policy of water management under any set of criteria is not simple or easy. No water quality management plan is complete without considering the health, aesthetic, conservation, and economic values for which those waters will be used. The Wisconsin Department of Natural Resources has exercised good judgment in considering and applying these many factors in the past. We hope that this conference in Duluth will consider the needs of all beneficial uses of the waters of Lake Superior in its recommendations.

(Applause.)

MR. FRANGOS: Thank you, Mr. Blackburn.

STATEMENT OF LLOYD L. FALK,
SENIOR CONSULTANT, ENGINEERING
DEPARTMENT, E. I. DU PONT DE
NEMOURS AND COMPANY, BARKSDALE, WISCONSIN

MR. FALK: Mr. Chairman and conferees:

My name is Lloyd L. Falk, and I am a Senior Consultant specializing in the field of water pollution control in the Engineering Department of the Du Pont Company. I would like to reiterate our expression of appreciation for the opportunity to speak here today.

I wish, first of all, to briefly outline work that has been done to treat "red water" for color removal. There have been reports in the literature of several studies. Perhaps these can best be summarized by quoting from an article by members of the U. S. Public Health Service's Cincinnati research facility, the organization that was the predecessor to today's Federal Water Pollution Control Administration. I quote from their summary about "red water:"

> "....biological treatment in domestic sewage treatment devices has been unsuccessful. Most of the standard chemical

mentods of treating dilute industrial wastes, such as neutralization, chemical precipitation, fractionation, extraction, ozonation, and electrolytic reduction, proved ineffective or not very promising."

They pointed out that chlorination reduced the color but did not eliminate it. Application of chlorination to our waste would probably make Boyd's Creek yellow instead of red. This would not eliminate the color problem along the shores of Chequamegon Bay.

Several years ago we actually built a soil absorption system for "red water." This was done in accordance with plans approved by the Department of Health after they assured us that there were no water wells in the area that could be affected. We tried the system and found that because the soil at Barksdale has so much clay it did not absorb "red water" to any significant extent. The system failed by eventually overflowing back to Boyd's Creek.

We have looked into adsorption of the color by activated carbon. It has been observed that the carbon removed the color but could not be regenerated for reuse. Many have examined activated carbon for tertiary treatment of wastewaters. Those few systems in use are based on being able to regenerate and reuse the carbon several times to achieve economic feasibility. We could only use the carbon once.

We have looked at permeation, using Du Pont's Permasep development with hollow fibers. The method is only partially effective. Ion exchange systems have been investigated, but regeneration of the exchangers gives us back "red water".

Complete evaporation and incineration is used to treat "red water" at federally-owned TNT plants. But these plants have waste streams several times the size of Barksdale, are on smaller bodies of water which cannot dilute these wastes, and have the advantage of scale in lowering the unit cost of this system. We would not have this advantage for our small commercial plant. Furthermore, these incineration systems are not free of air pollution and, I might add, residue problems.

Because color is our problem along the shore of Chequamegon Bay, we proposed to the Resources Development Board of the Wisconsin Department of Natural Resources that improved dispersion of "red water" in deeper waters would eliminate the potential nuisance and meet the objectives of the water quality criteria so as not to interfere with beneficial uses of the bay. We proposed to them that a study be made of Chequamegon Bay regarding its currents, exchange rate with Lake Superior, temperature stratification, etc. Our concern was that, while we knew we could get rapid initial mixing of wastes with the bay waters, we wanted to make sure that stagnation of bottom waters would not defeat our dispersion efforts.

Du Pont issued a grant to the Marine Studies Center of the University of Wisconsin to make such a study in the summer of 1968. I attach to my statement, for the record, a copy of the University's report, entitled "The Hydrography of Chequamegon Bay," dated January 1969, which you all have copies of now.

(The report follows.)

THE HYDROGRAPHY OF CHEQUAMEGON BAY

by

Robert A. Ragotzkie
William Ahrnsbrak
Adam Synowiec

Technical Report No. 1

Marine Studies Center
University of Wisconsin
Madison, Wisconsin

Madison, Wisconsin
January 1969

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Financial support for this research was provided by a grant from the E.I. Du Pont de Nemours and Company.

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I. INTRODUCTION

Chequamegon Bay is located on the south shore of Lake Superior at Ashland, Wisconsin (Fig. 1). The Bay is elongated in shape with its long axis oriented NE-SW and opens to Lake Superior at the northeast corner of the Bay. It is 19 kilometers long and 8 kilometers wide. It has a surface area of 166 km^2 and a mean depth of 8.6 meters. Figure 29 shows the general bathymetry of the Bay; detailed sounding data are shown on Lake Survey Chart No. 961. The south end and entire east side of the Bay are very shallow, less than five meters deep, while the deeper water occurs along the western shore. The depths increase north-northeastward along the long axis of the Bay. There is no sill separating the Bay from Lake Superior.

II. NATURE OF THE STUDY

The Marine Studies Center of the University of Wisconsin at Madison carried out studies on Chequamegon Bay during the summer of 1968. Two scientists, Dr. Adam Synowiec, Visiting Professor of Meteorology, and Mr. William Ahrnsbrak, Graduate Research Assistant in Meteorology, established residence in the Chequamegon Bay area during the months of July and August 1968 to carry out the major portion of the field program, some segments of which necessitated daily observations. Prior to this, during June, some reconnaissance work had been done. At various times during the summer, other personnel from the University of Wisconsin also assisted in the program. During early September, with the assistance of personnel of the Laboratory of Water Chemistry, University of Wisconsin, a dye tracer experiment was carried out. On several occasions during the summer, airborne infrared measurements of the surface temperature of the bay were made.

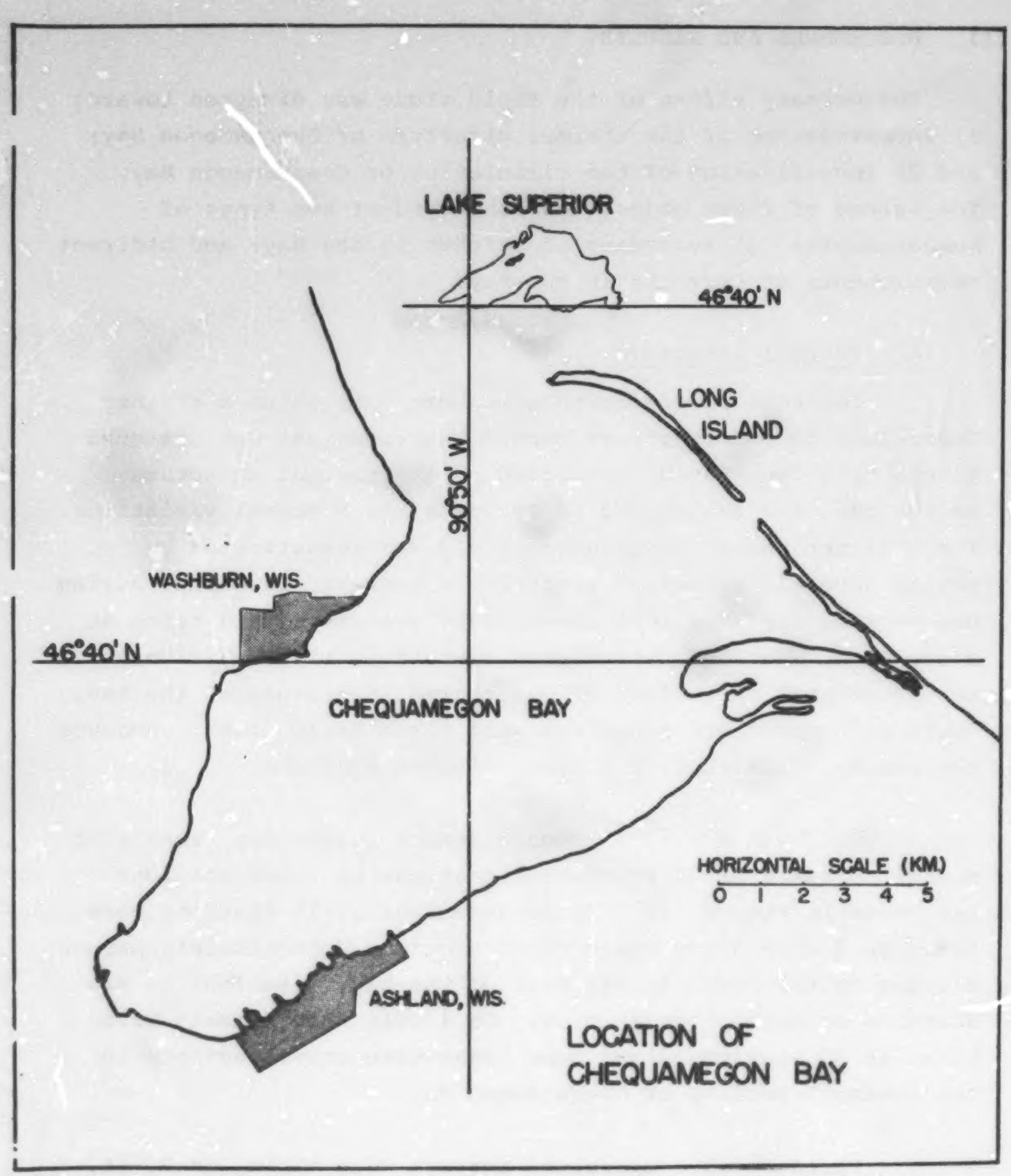


Figure 1. Location of Chequamegon Bay, Lake Superior. The latitude-longitude intersection on the inset map is the same as that indicated on the map of Chequamegon Bay.

III. PROCEDURES AND RESULTS

The primary effort of the field study was directed toward: 1) Investigation of the thermal structure of Chequamegon Bay; and 2) Investigation of the circulation of Chequamegon Bay. The second of these objectives consisted of two types of measurements: a) recording of seiches in the Bay; and b)direct measurements of currents in the Bay.

A. Thermal Structure

Two sets of temperature measurements using a Whitney Underwater Thermometer were made. The first set was designed to evaluate the spatial variation of the thermal structure of the Bay, and the second to evaluate the temporal variations. The "instantaneous" temperature field was investigated by making several "synoptic" temperature surveys, in which, during one working day, vertical temperature soundings were taken at a number of stations distributed over the entire Bay. To observe temporal variations of the thermal structure of the Bay, vertical temperature soundings were taken daily (i.e., whenever the weather permitted) at three selected stations.

On 3 and 4 July a reconnaissance survey was taken with soundings taken at 72 stations (locations of these stations are shown in Figure 2). The measurements at 15 stations were taken on 3 July along three cross sections approximately perpendicular to the longitudinal axis of the bay, with four to six stations on each cross section. On 4 July measurements were taken at 50 stations along nine transverse cross sections in the southern portion of Chequamegon Bay.

Three other temperature surveys were taken, on 9, 14, and 22 August. In these surveys observations were concentrated in the area of deeper water, because there was usually no significant temperature structure in the southern portion of the Bay. The station locations and cross sections are shown in Figure 3.

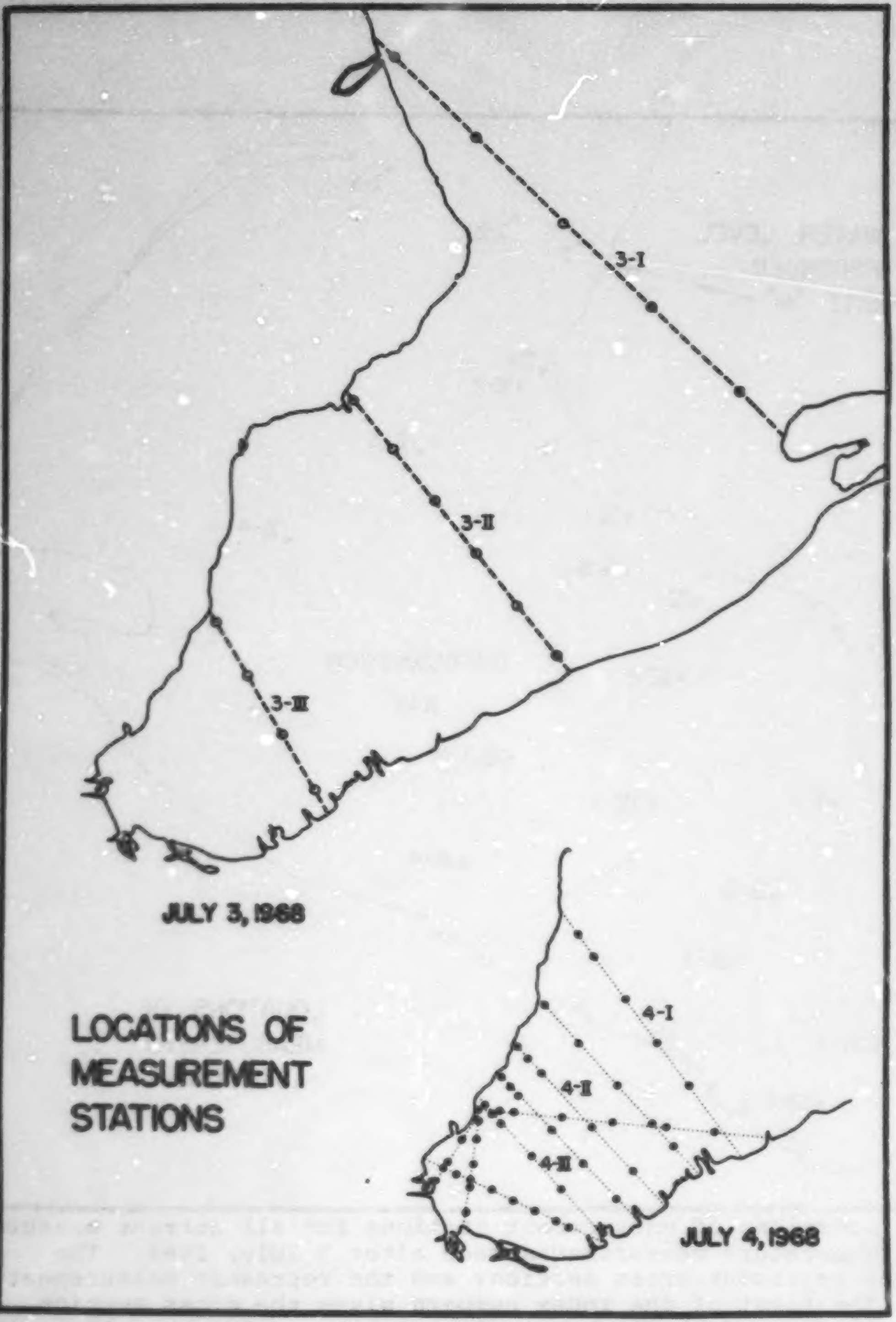


Figure 2. Locations of measurement stations for temperature survey of 3 and 4 July, 1968. The dashed and dotted lines represent cross sections, the solid and open circles represent measurement stations. The first of the reference numbers on cross sections give the date on which the measurements were made, the second gives the cross section numbers.

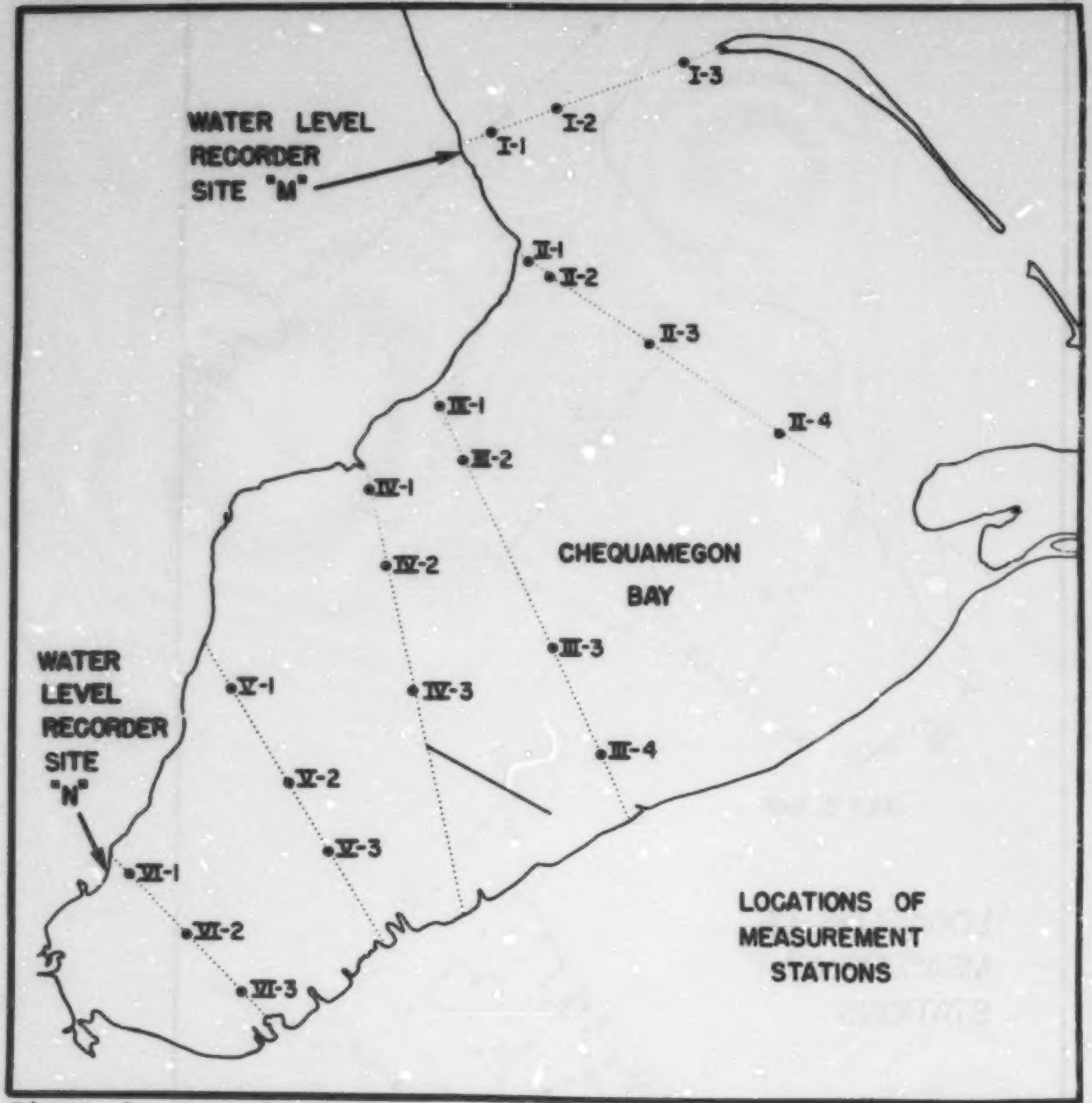


Figure 3. Locations of measurement stations for all current measurements and temperature measurements made after 5 July, 1968. The dotted lines represent cross sections and the represent measurement stations. The first of the index numbers gives the cross section number and the second gives the station number.

Results of the four temperature surveys are shown as a series of cross sections in Figures 4-7. Solid lines on the cross sections are isotherms, drawn at one centigrade degree intervals. Bathymetric data for these and all other figures were taken from the U.S. Army Corps of Engineers U.S. Lakes chart number 961. The left side of the cross sections corresponds to the west shore of the Bay, the right side corresponds to the east shore.

At three stations, I-2, IV-2, and V-2 (Figure 3) vertical temperature soundings were taken daily, whenever weather permitted. At station I-2, data are available for the periods 19 July-3 August and 8-22 August. At station IV-2 soundings were taken during the period of 8-17 August and at station V-2 the soundings were taken during the periods 16 July-1 August and 8-27 August.

Results of the time series of vertical temperature soundings at the three selected stations I-2, IV-2, and V-2 (Figure 3) are shown in Figures 8-12. On each figure water temperature is shown as a function of depth and time. Isotherms have been drawn at 2°C intervals. Solid lines are shown for days when the temperature was measured and interpolated dashed lines are shown when no measurements were made (usually due to bad weather).

Daily mean winds are also shown on the figures. Wind direction is measured and speed is estimated every four hours at the U.S. Coast Guard station in Bayfield, Wisconsin, located 11 miles north of Washburn, Wisconsin. These values have been multiplied by four and added vectorially to yield a daily resultant wind passage. Vectors shown on the figures have direction indicating wind direction (a wind from the west is represented by an arrow pointing towards the right) and length proportional to the amount of wind passage (according to the scale shown on each figure).

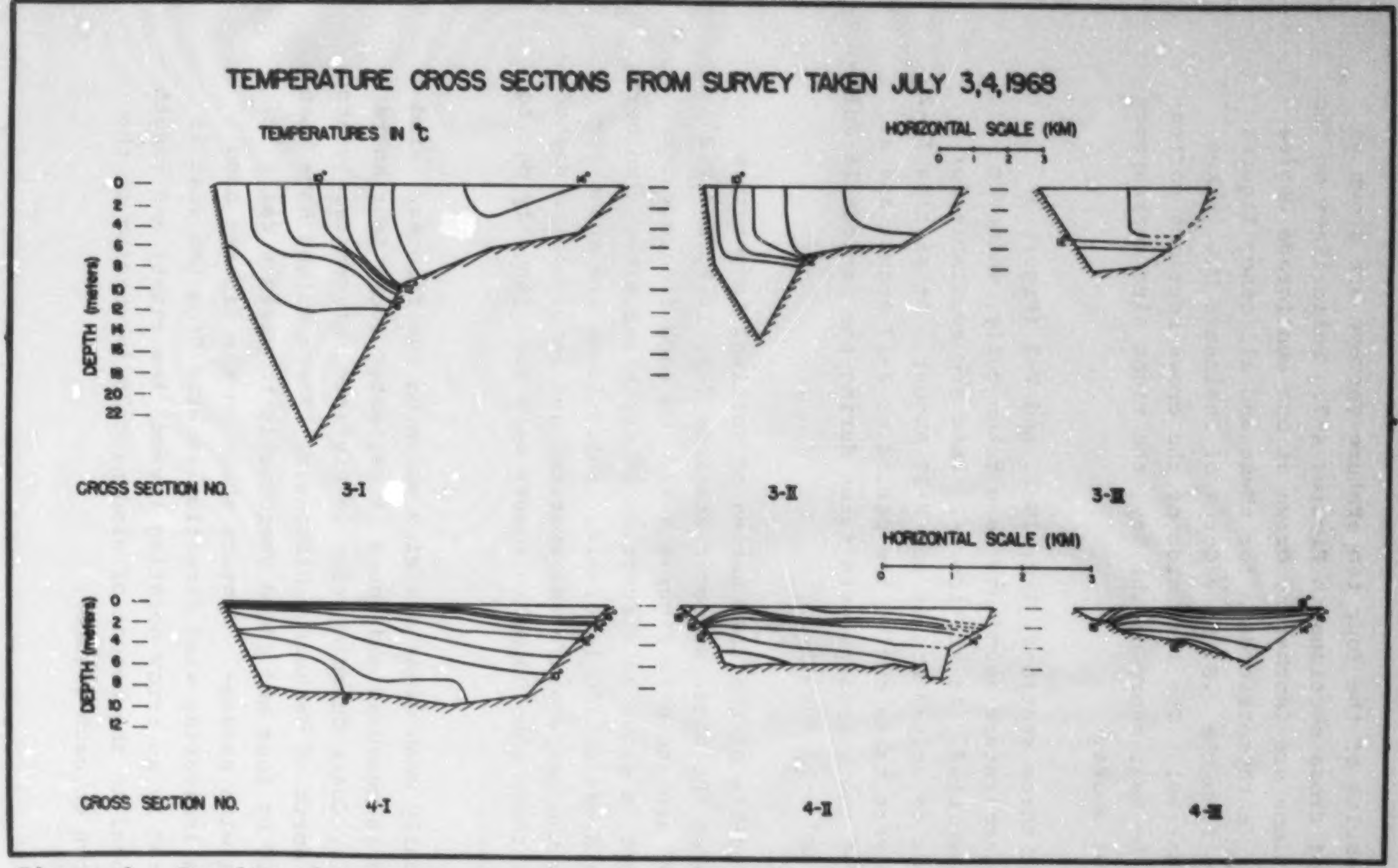


Figure 4. Results of temperature survey, 3 and 4 July, 1968. Isotherm interval = 1°C. For location of cross sections see Figure 2.

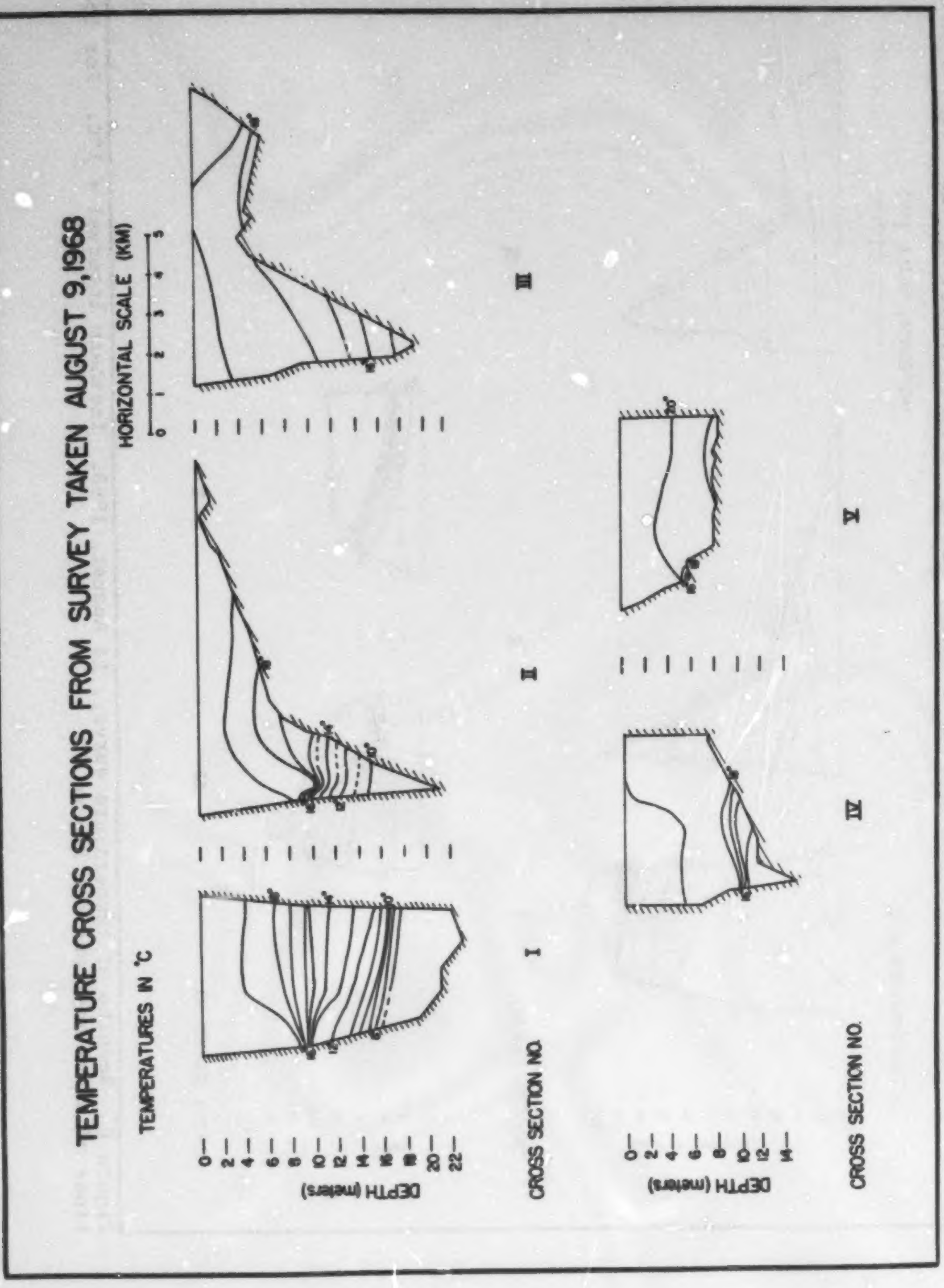


Figure 5. Results of temperature survey, 9 August, 1968. Isotherm interval = 1°C. For locations of cross sections see Figure 3.

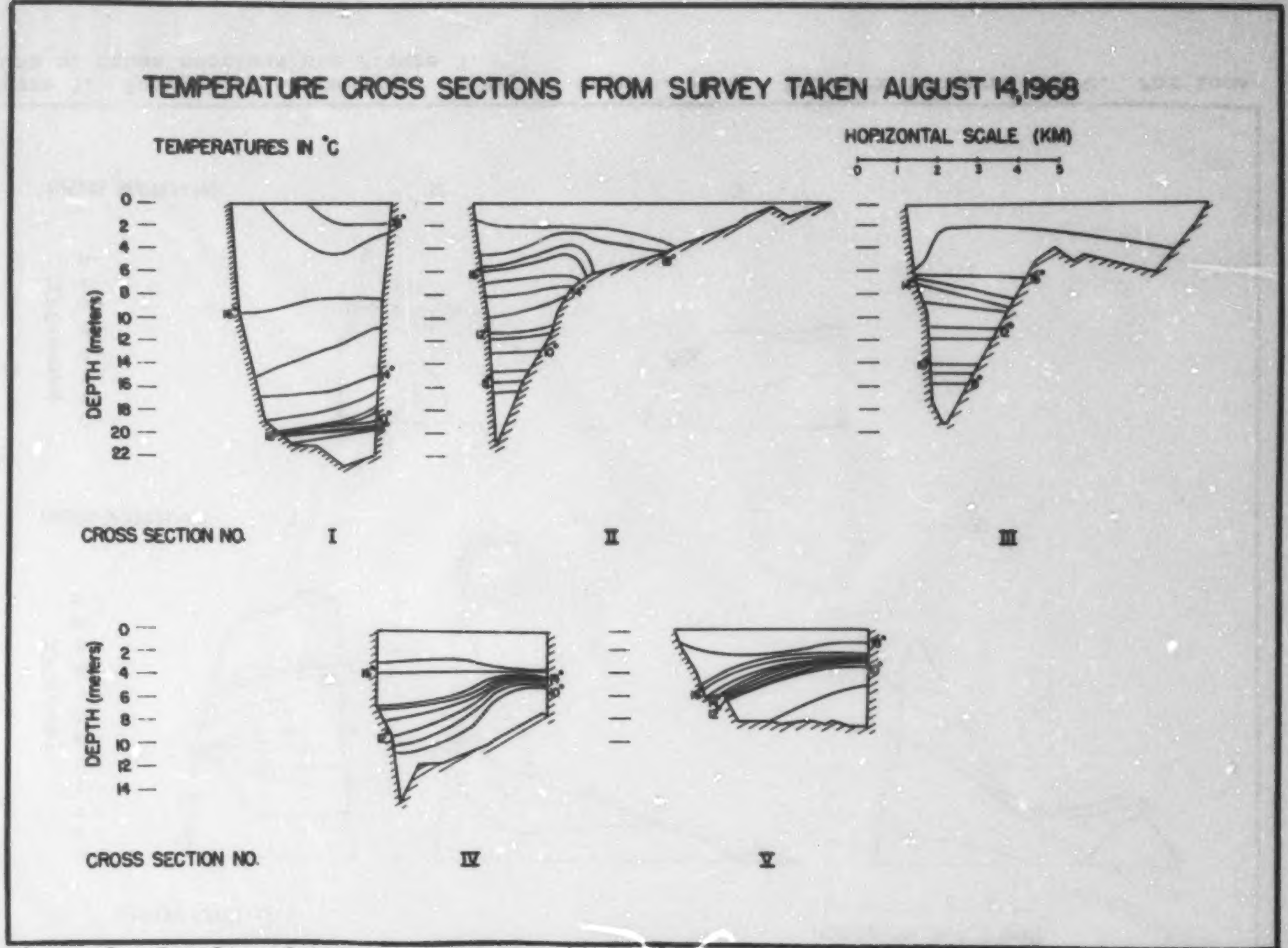


Figure 6. Results of temperature survey, 14 August, 1968. Isotherm interval = 1°C. For locations of cross sections see Figure 3.

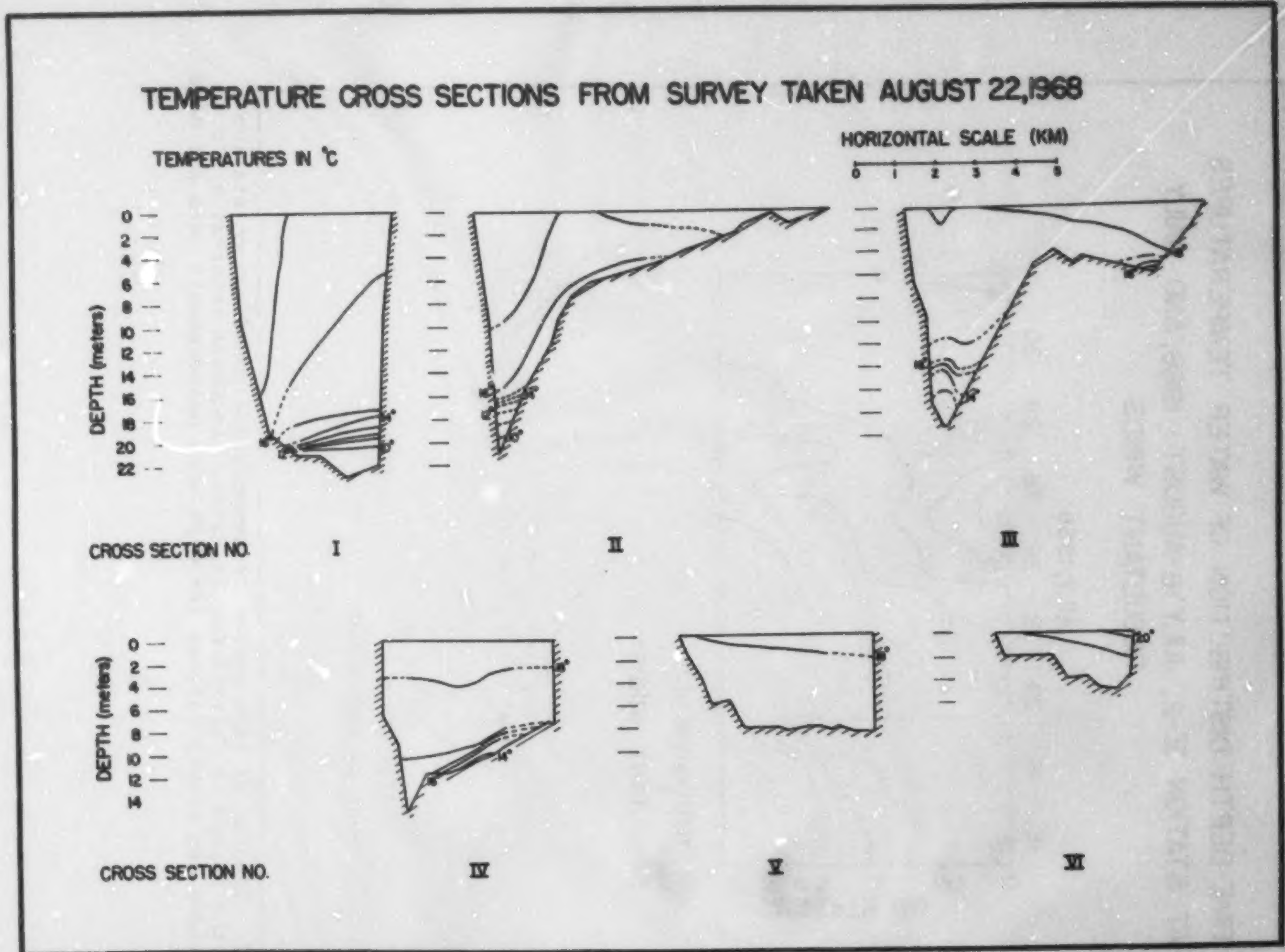


Figure 7. Results of temperature survey, 22 August, 1968. Isotherm interval = 1°C. For locations of cross sections see Figure 3.

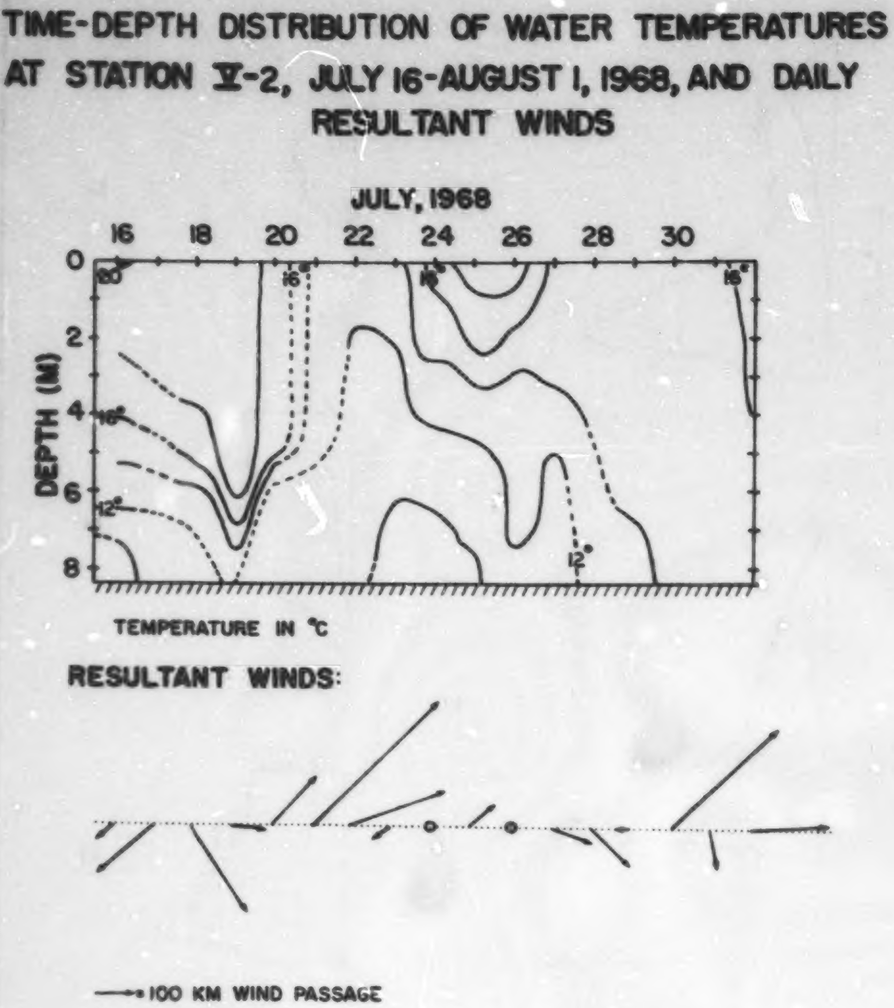


Figure 8. Results of time series of temperature soundings at station V-2 for the period 16 July--1 August, 1968. Isotherm interval = 2°C. Dashed lines are interpolations for days when measurements were not made.

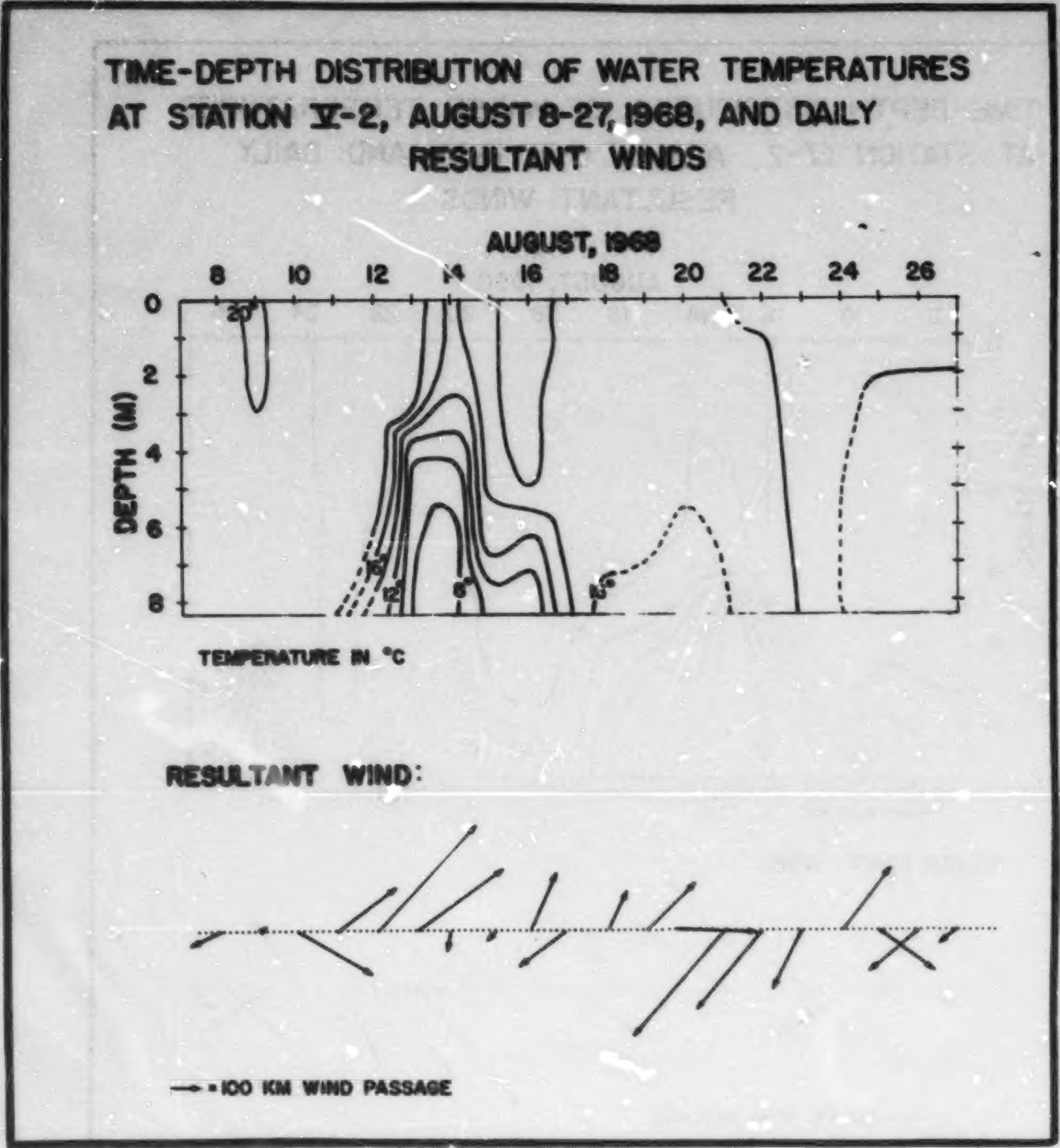


Figure 9. Results of time series of temperature soundings at station V-2 for the period 8-27 August, 1968. Isotherm interval = 2°C. Dashed lines are interpolations for days when measurements were not made.

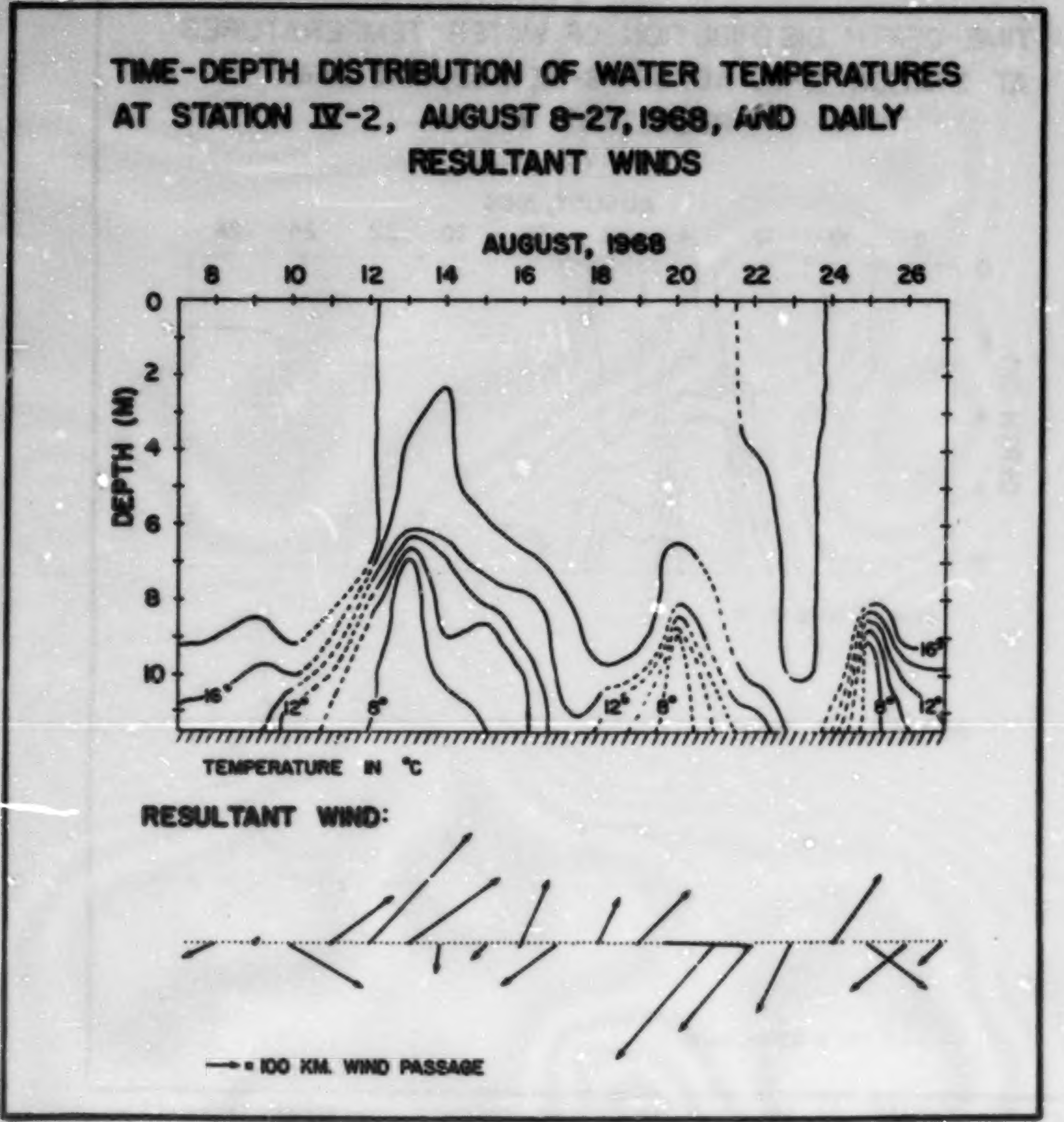
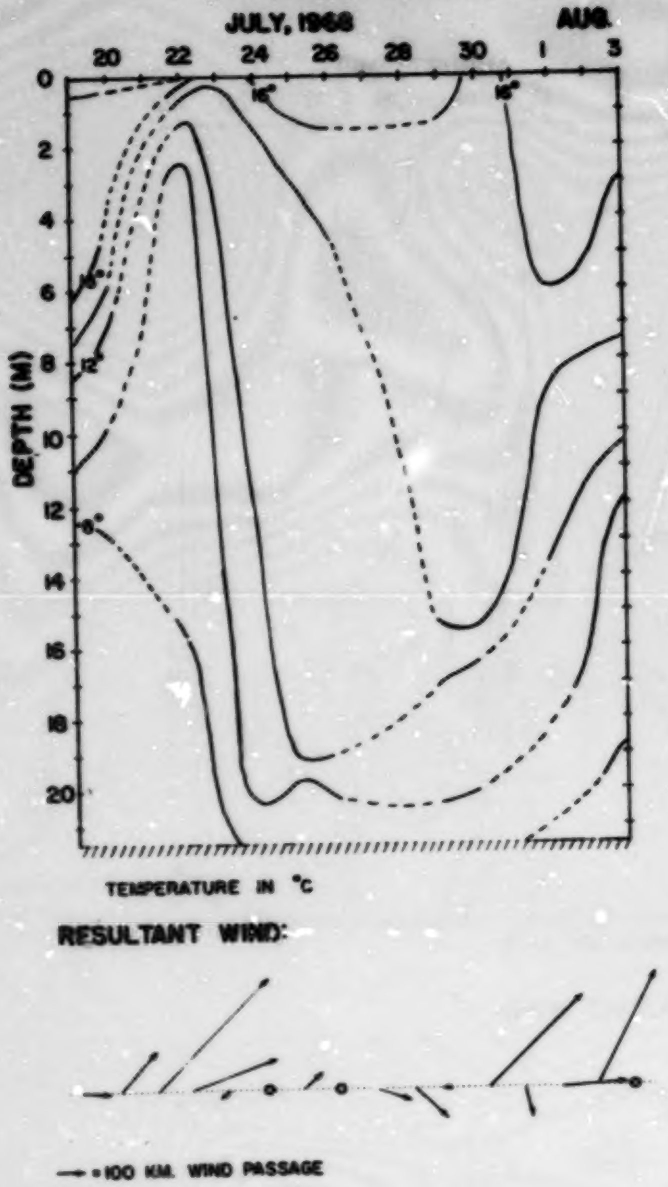


Figure 10. Results of time series of temperature soundings at station IV-2 for the period 8-27 August, 1968. Isotherm interval = 2°C. Dashed lines are interpolations for days when measurements were not made.



TIME-DEPTH DISTRIBUTION OF WATER TEMPERATURES AT STATION I-2, JULY 19-AUGUST 3, 1968, AND DAILY RESULTANT WINDS

Figure 11. Results of time series of temperature soundings at station I-2 for the period 19 July--3 August, 1968. Isotherm interval = 2°C. Dashed lines are interpolations for days when measurements were not made.

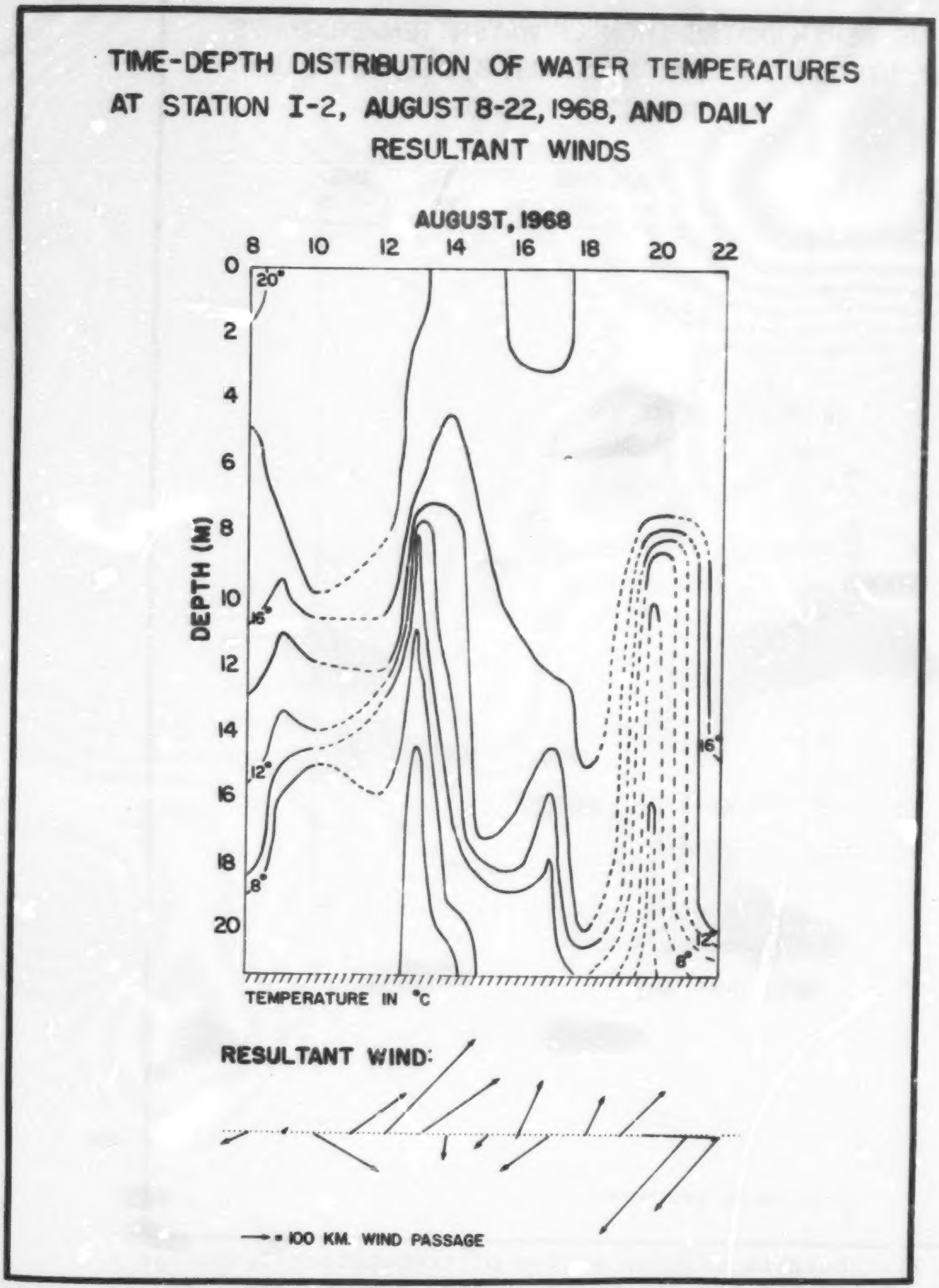


Figure 12. Results of time series of temperature soundings at station I-2 for the period 8-22 August, 1968. Isotherm interval = 2°C. Dashed lines are interpolations for days when measurements were not made.

Results of the time series at the three stations are also shown as longitudinal cross sections for each day. (Figures 13-16). The cross section was constructed by straightening the line obtained by connecting the three points and extending the line southeast to the end of the Bay. Isotherms are shown at two degree intervals, and temperatures are in degrees centigrade. Winds indicated on the figures are mean daily winds.

B. Circulation

1. Seiches

To investigate seiches occurring in the Bay, two water level recorders (Leupold and Stevens, type F) were installed near the northeast and southwest ends of Chequamegon Bay. The instrument at the northeast end of the Bay was installed on the property of Mr. Walter Mick (hereafter referred to as site "M") and the one at the southwest end was installed on the property of Mr. Frank Nycek (hereafter referred to as site "N") (Fig. 3). The instruments were mounted on stilling wells consisting of two 55 gallon drums welded end to end with two 1/4 inch holes drilled in them near the bottom. These instruments functioned almost continuously during the period 6 July--26 August.

A sample of the water level records from the two sites, "M" and "N" is shown in figure 17. Changes in water level are shown as a function of time.

Preliminary evaluation of all of the records shows that oscillations in the water level were occurring continuously throughout the study period. A representative sample of the records has been visually analyzed for oscillation periods recorded. Periods shorter than three hours which were identified are listed in table 1.

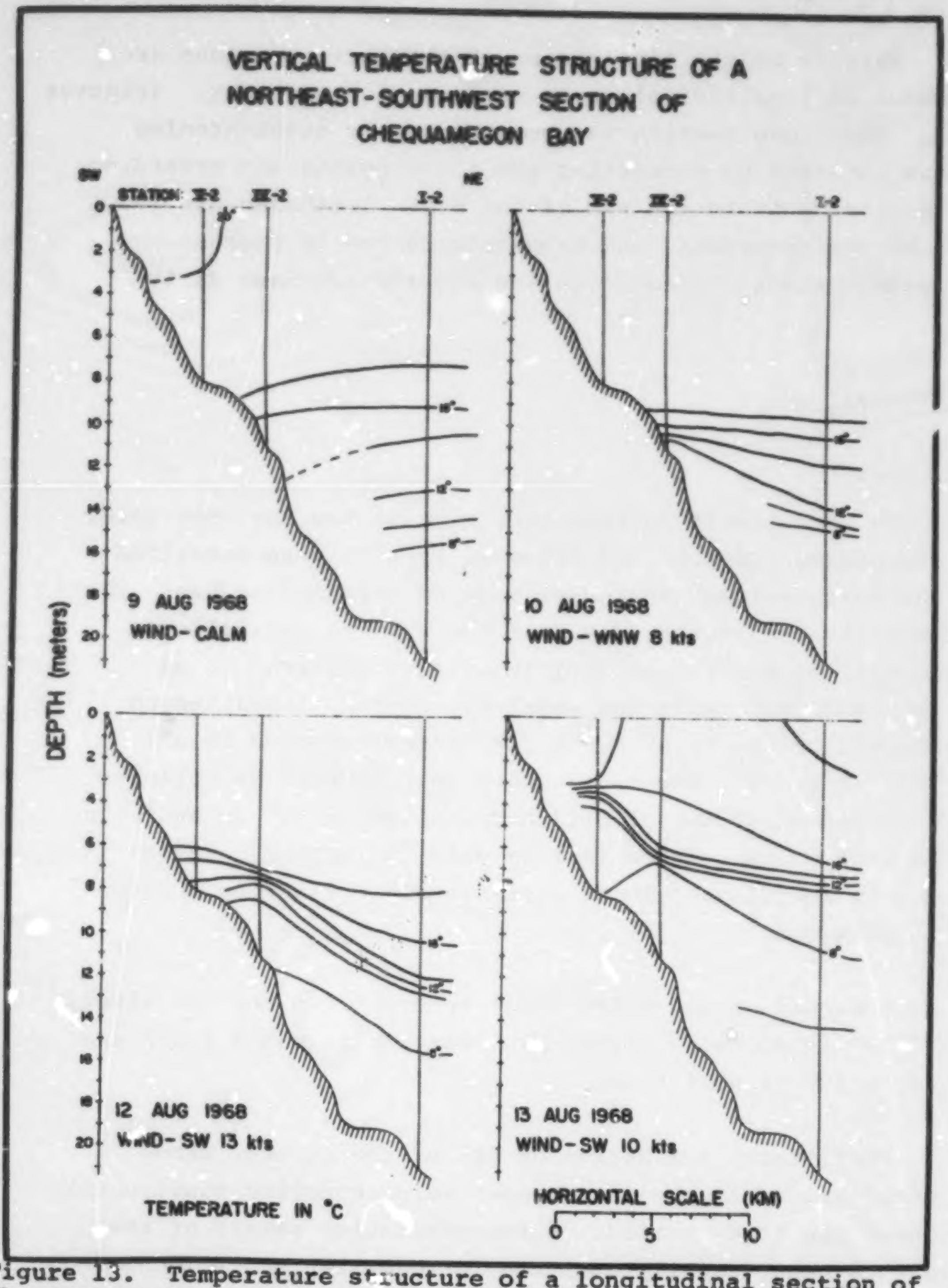


Figure 13. Temperature structure of a longitudinal section of Chequamegon Bay, 9-13 August, 1968, constructed from measurements at stations I-2, IV-2, and V-2. Isotherm interval is 2°C. Wind indicated is 24 hour vector mean wind, obtained from Bayfield Coast Guard Station. For locations of stations see Figure 3.

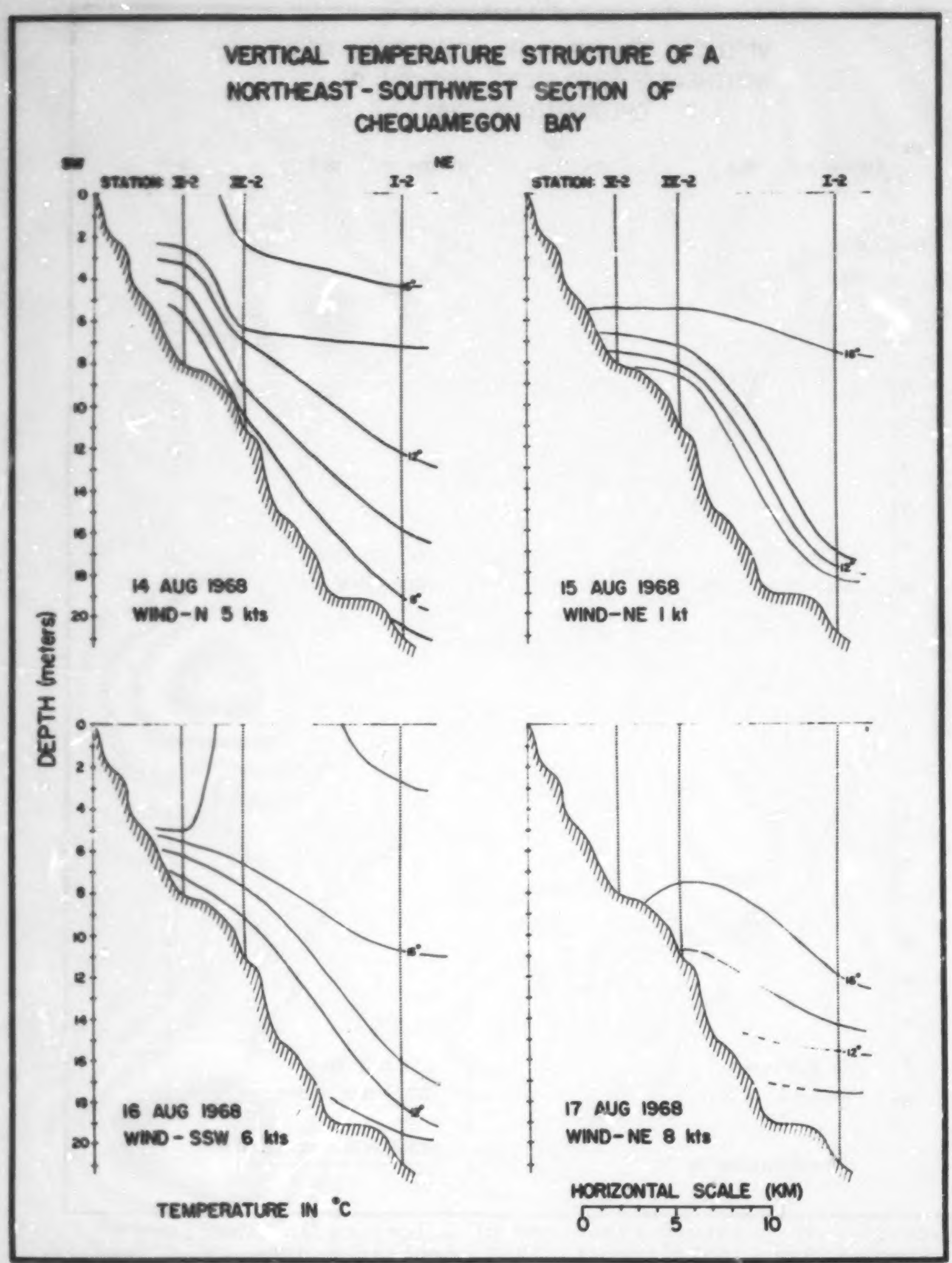


Figure 14. Temperature structure of a longitudinal section of Chequamegon Bay, 14-17 August, 1968, constructed from measurements at stations I-2, IV-2, and V-2. Isotherm interval is 2°C. Wind indicated is 24 hour vector mean wind, obtained from Bayfield Coast Guard Station. For locations of stations see Figure 3.

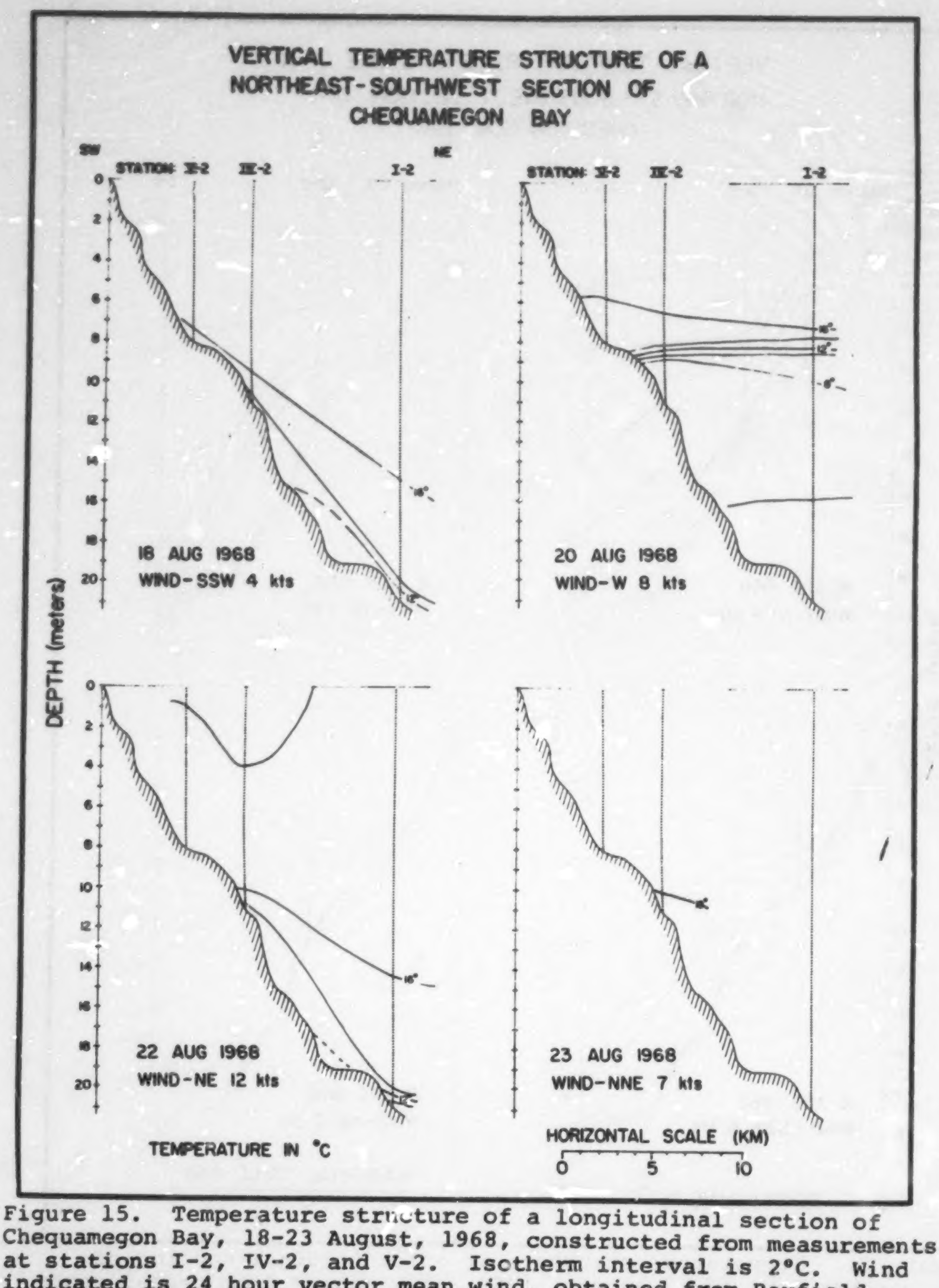


Figure 15. Temperature structure of a longitudinal section of Chequamegon Bay, 18-23 August, 1968, constructed from measurements at stations I-2, IV-2, and V-2. Isotherm interval is 2°C. Wind indicated is 24 hour vector mean wind, obtained from Bayfield Coast Guard Station. For locations of stations see Figure 3.

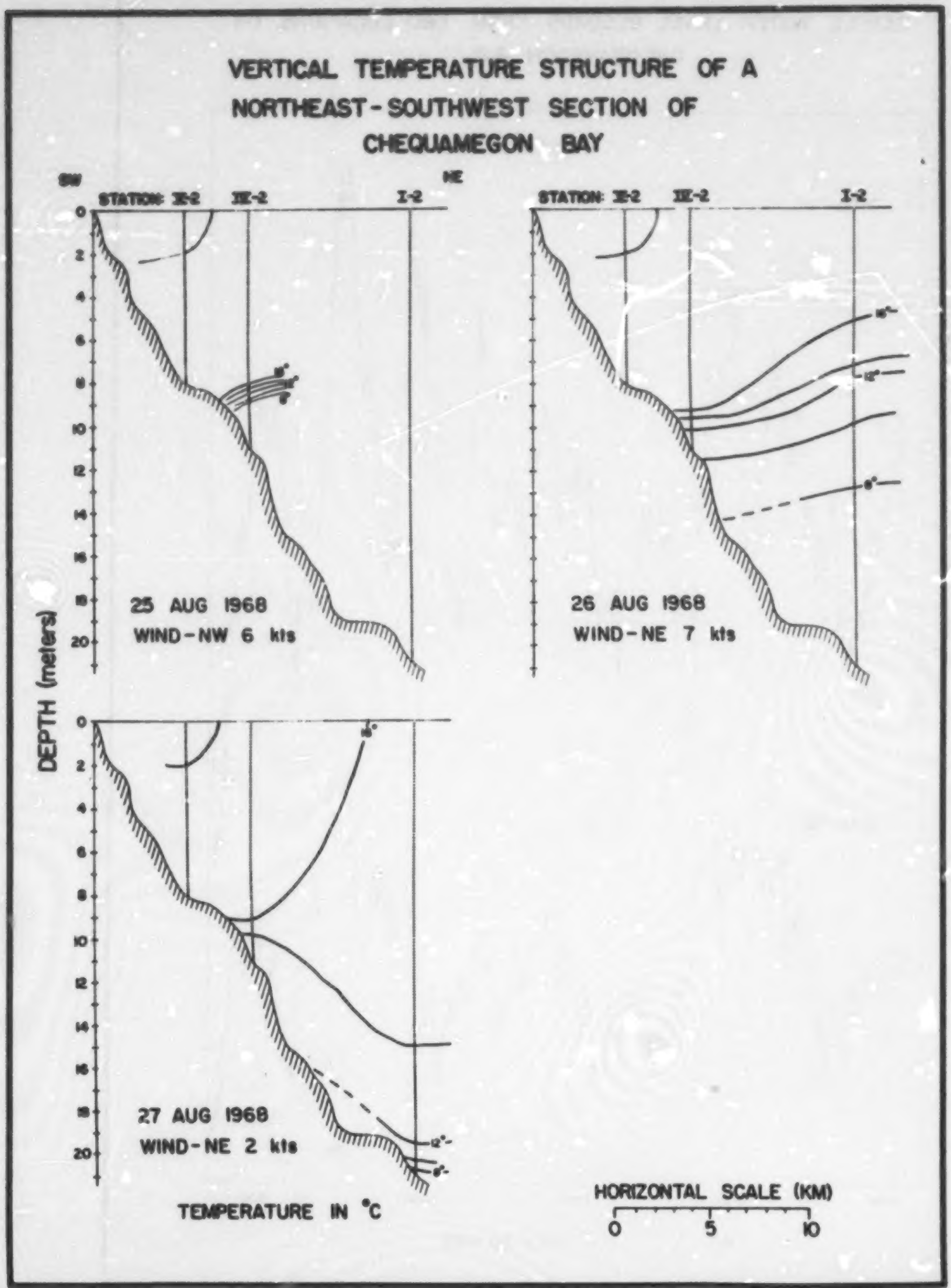


Figure 16. Temperature structure of a longitudinal section of Chequamegon Bay, 25-27 August, 1968, constructed from measurements at stations I-2, IV-2, and V-2. Isotherm interval is 2°C. Wind indicated is 24 hour vector mean wind, obtained from Bayfield Coast Guard Station. For locations of stations see Figure 3.

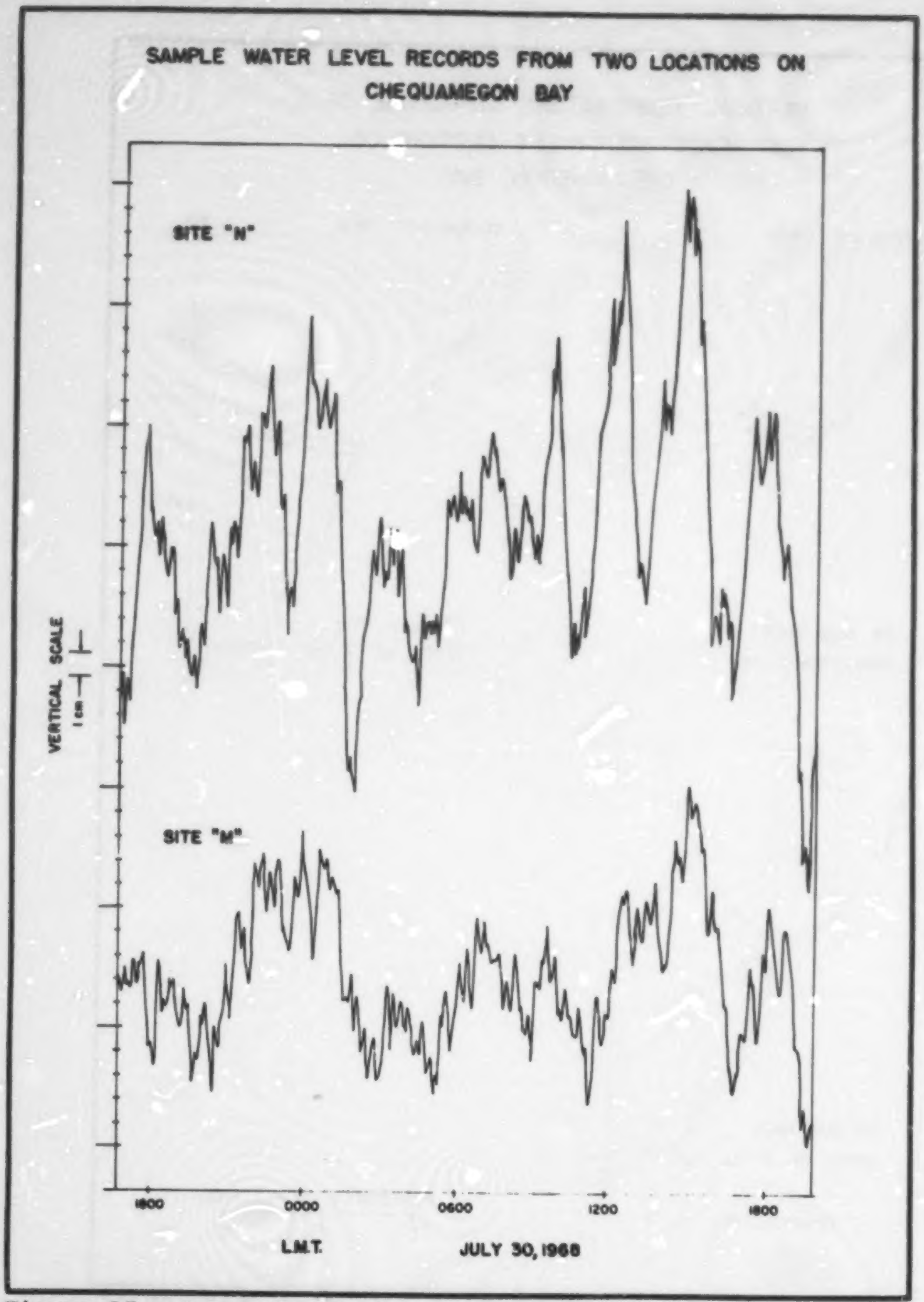


Figure 17. A sample of the water level record for two locations on Chequamegon Bay for 29, 30 July, 1968. For locations of stations see Figure 3.

Theoretical periods of the various modes of an oscillating basin can be calculated on the basis of the geometry of the system. One such method of doing this is Merian's formula:

$$T_n = \frac{2 \cdot l}{n \cdot \sqrt{g \cdot h}}$$

where l = length of the basin, h = mean depth of the water, g = acceleration due to gravity, n = wave number, and T_n = period. Calculated periods, based on this method are also listed in table 1.

Table 1. Periods of oscillations in the water level of Chequamegon Bay.

THEORETICAL PERIODS (Merian's formula)		OBSERVED PERIODS	
		Site "M"	Site "N"
n	T_n (minutes)	(minutes)	(minutes)
		13	11
3	23	21	21
2	34.5	37	36
1	69	60	62
			96
			140
		163	

From the value in table 1 it appears that the uninodal (n = 1), binodal (n = 2), and trinodal (n = 3) seiches all exist in the Bay. Since the wave whose length is equal to the length of Chequamegon Bay has a theoretical period of 69 minutes, it can be seen that periods of 70 minutes and longer are due to oscillations which extend beyond the mouth of Chequamegon Bay.

The frequency of occurrence of ranges of oscillations observed on all records are given in table 2. Each day's record was divided into 8 hour segments and the maximum range recorded in each segment was noted. The most frequently occurring range at site "M" is 15 - 20 cm., and at site "N" is 10 - 15 cm.

The significance of these oscillations within the Bay to horizontal water movement in the Pay is discussed in section IV.

Table 2. Frequency of occurrence of ranges of vertical oscillations observed in Chequamegon Bay.

Range (cm.)	Site "M" (% occurrence)	Site "N" (% occurrence)
0 - 5	0	0
5 - 10	1.5	15.2
10 - 15	9.2	34.8
15 - 20	22.9	24.2
20 - 25	20.6	16.7
25 - 30	11.5	5.3
30 - 35	16.0	2.3
35 - 40	4.6	0.8
40 - 45	3.8	0.8
45 - 50	4.6	
50 - 60	2.3	
60 - 75	3.1	

2. Currents

All of the current measurements were made using free drogues, a method which has long been in use in hydrographic work (Mitchell, 1867; Carpenter, 1872; Cromwell, et. al., 1954). The method is reviewed by Knauss (1963) and consists of simply placing an object (for instance a drogue or float) in the water and measuring its distance and direction of movement during a known period of time. These measurements then yield an averaged value of the velocity, in an Eulerian co-ordinate system. According to Knauss and others current measurements made with this method yield values to an accuracy of 5 to 10 percent.

Drogues used in this study were made of .032" ST sheet aluminum. Most measurements were made using 1/4 M^2 drogues, although a few 1/2 M^2 drogues were used. Floats for the drogues were made out of one quart plastic bottles. Current direction was determined by using a Brunton type compass to take magnetic bearings on the float of the drogues from its launching point. Distance traveled by the drogues was measured with a propellor driven taffrail log extended from the gunwale of the boat, and time elapsed was measured with a stop watch.

Ideally, an instantaneous or synoptic picture of the horizontal distribution of currents is desired, however, the time required to make a sufficiently large number of current measurements by the free drogue method precluded reaching this ideal. Compromise was therefore necessary.

Two strategies were employed:

1) Several synoptic surveys were made in which currents were measured at several depths at from 10 to 16 stations throughout the Bay,

2) Several time series were made by repeatedly measuring the currents at several depths at station V-2.

Synoptic current surveys were made on 26 July, 1 August, and 10 August. Current measurements on 26 July were made at one and five meters at 16 stations along cross sections II,III, and V. The survey on 1 August consisted of measurements of the currents at one, five, and ten meters at all stations on cross sections I - V, with the exception of station IV-2. On 10 August, due to strong winds and rough water, it was impossible to obtain measurements in the northeast portion of the Bay. With the exception of this area, this survey was identical to that of 1 August.

Figures 18 - 25 show results of the three current surveys. In all figures in this report, currents referred to as surface currents are currents measured with the center of mass of the drogue at a depth of one meter. Currents are represented by vectors which are drawn with the base of each vector at the point at which the measurement was taken. The orientation of the vector indicates current direction and the length of the vector is proportional to current speed. Locations of all current measurement stations are shown in figure 3. Winds indicated on the figures are those observed nearest to the time of the current survey.

An examination of the temporal variations in the currents is necessary to examine the effect of the time span required to complete a survey over the entire Bay. To investigate these variations, three time series of current measurements were made, on 16 July, 22 August, and 26 August. These series were made by repeatedly measuring the currents at several depths at station V-2.

On 16 July only the currents at one meter were measured, over a period of 75 minutes. On 22 August currents were measured at one, five, and seven meters over a period of 58 minutes. On 26 August currents were again measured at one, five, and seven meters. These measurements were taken over a period of 210 minutes.

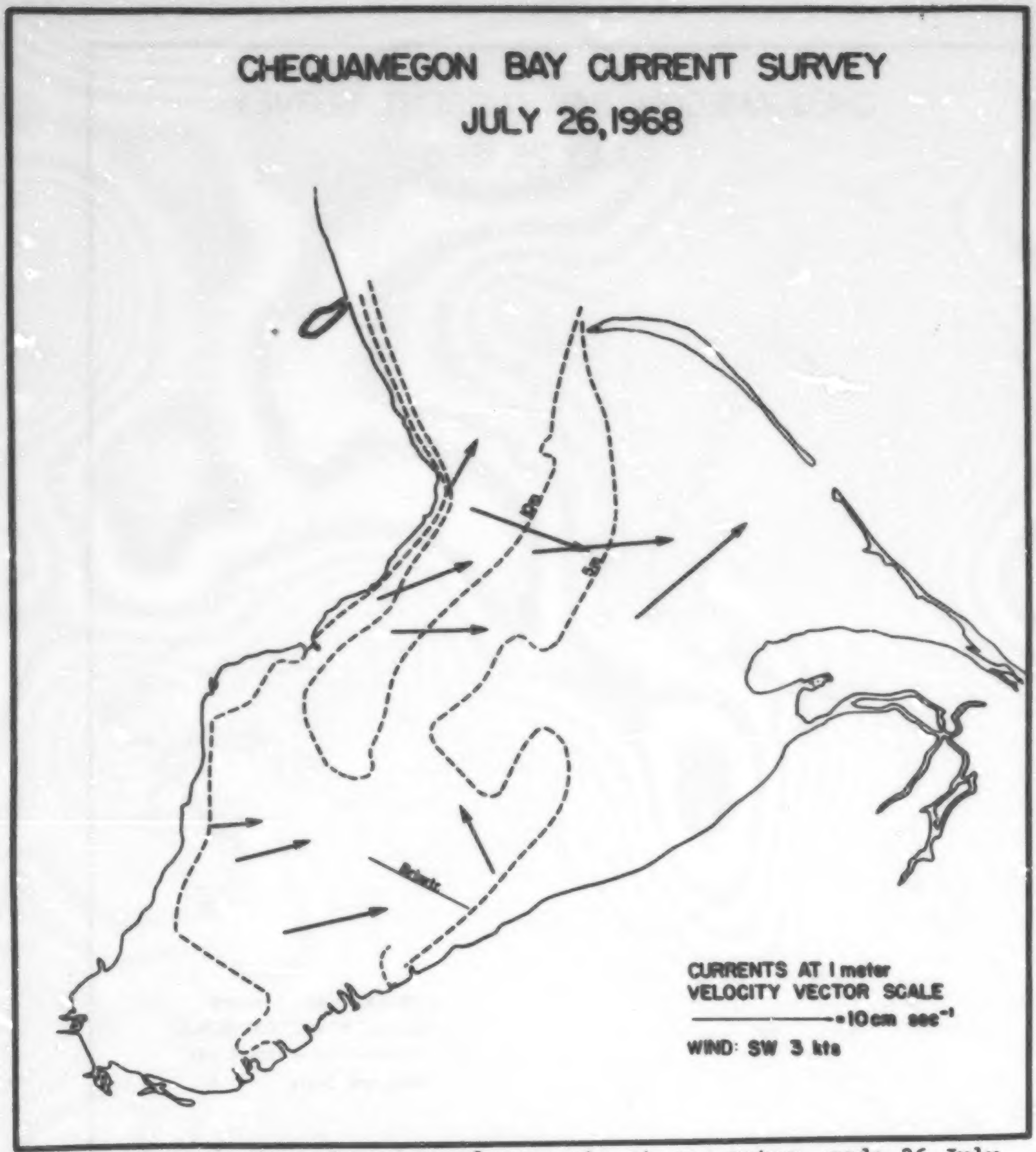


Figure 18. Results of survey of currents at one meter, made 26 July, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

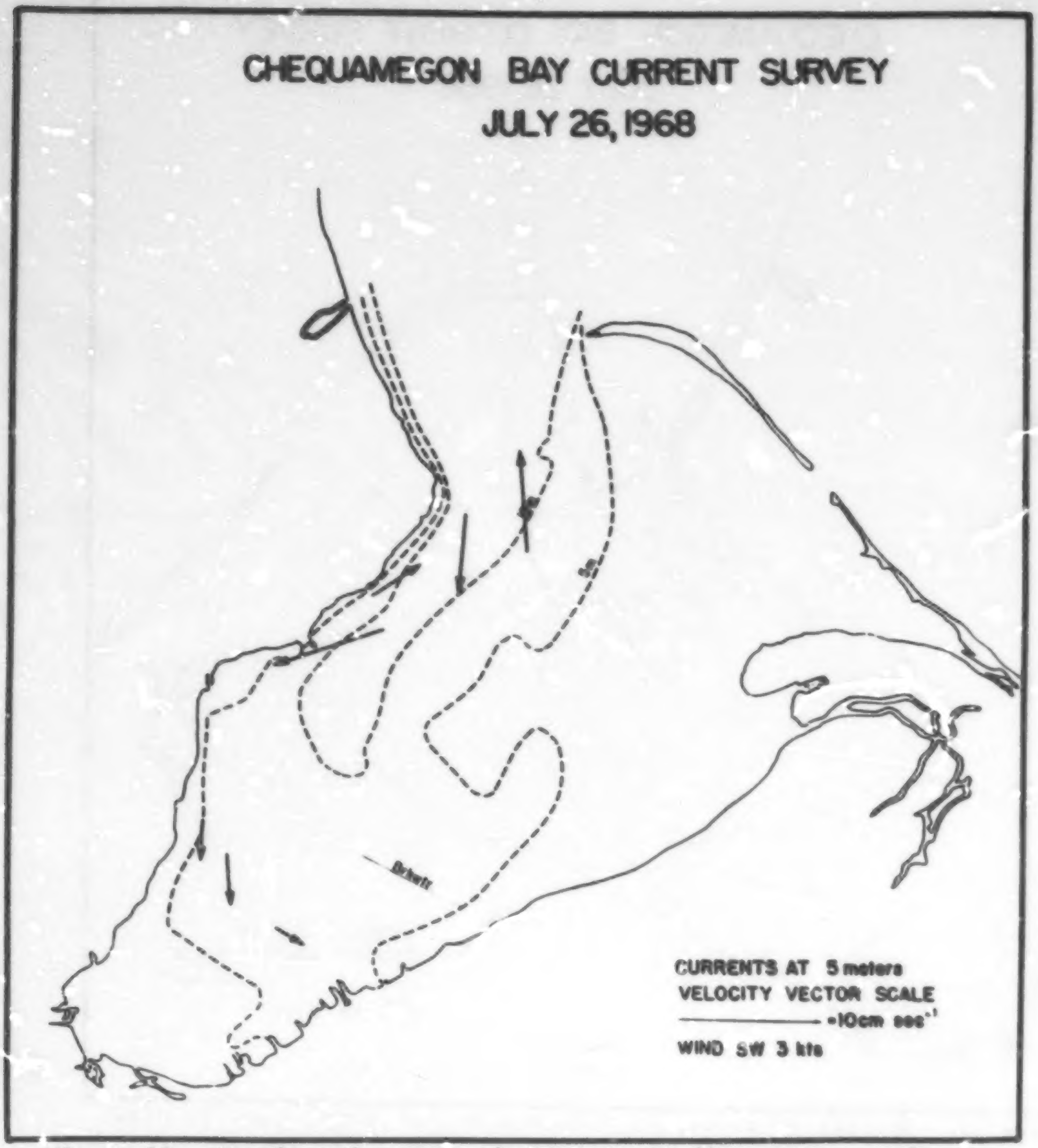


Figure 19. Results of survey of currents at five meters, made 26 July, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

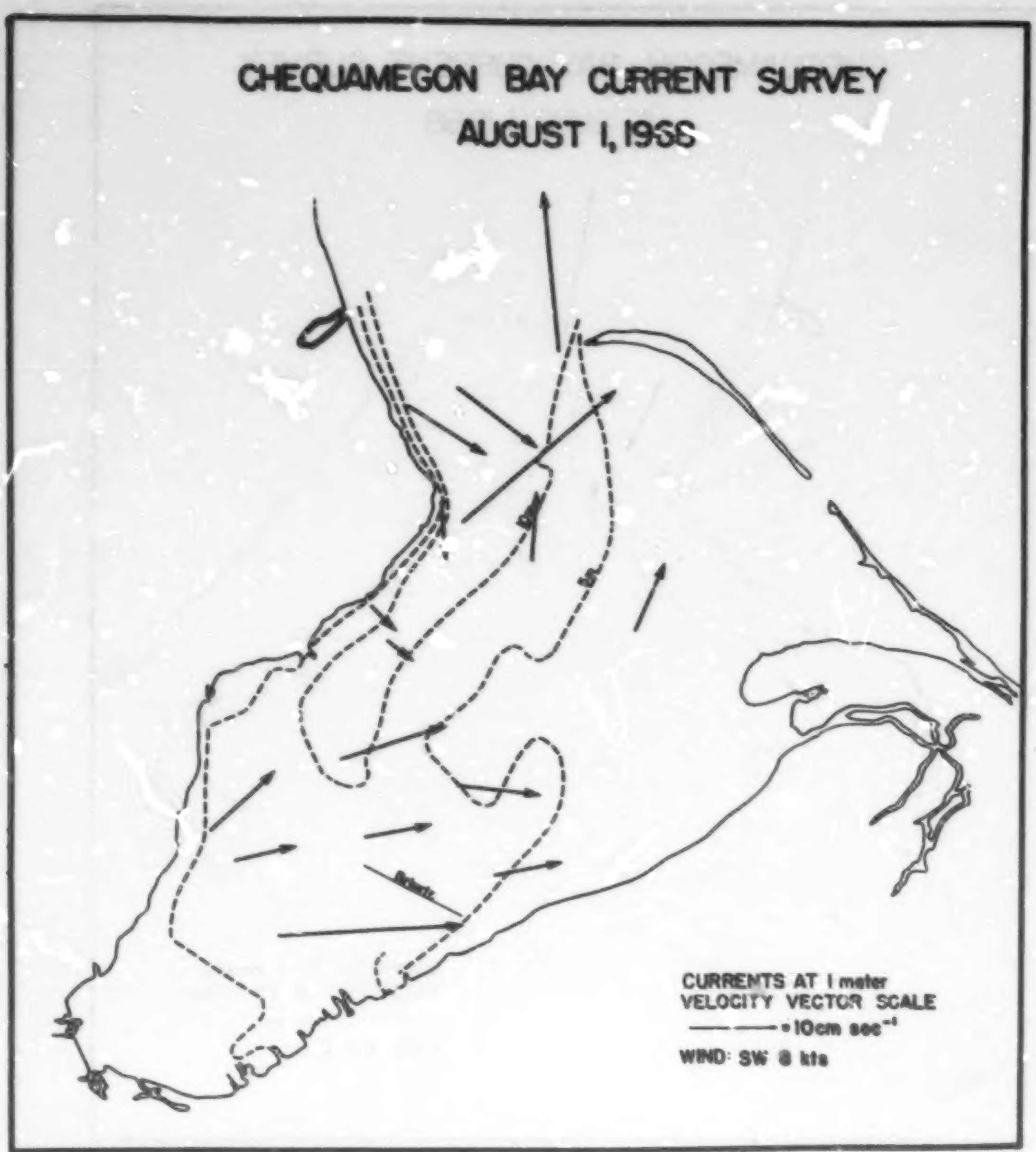


Figure 20. Results of survey of currents at one meter, made 1 August, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

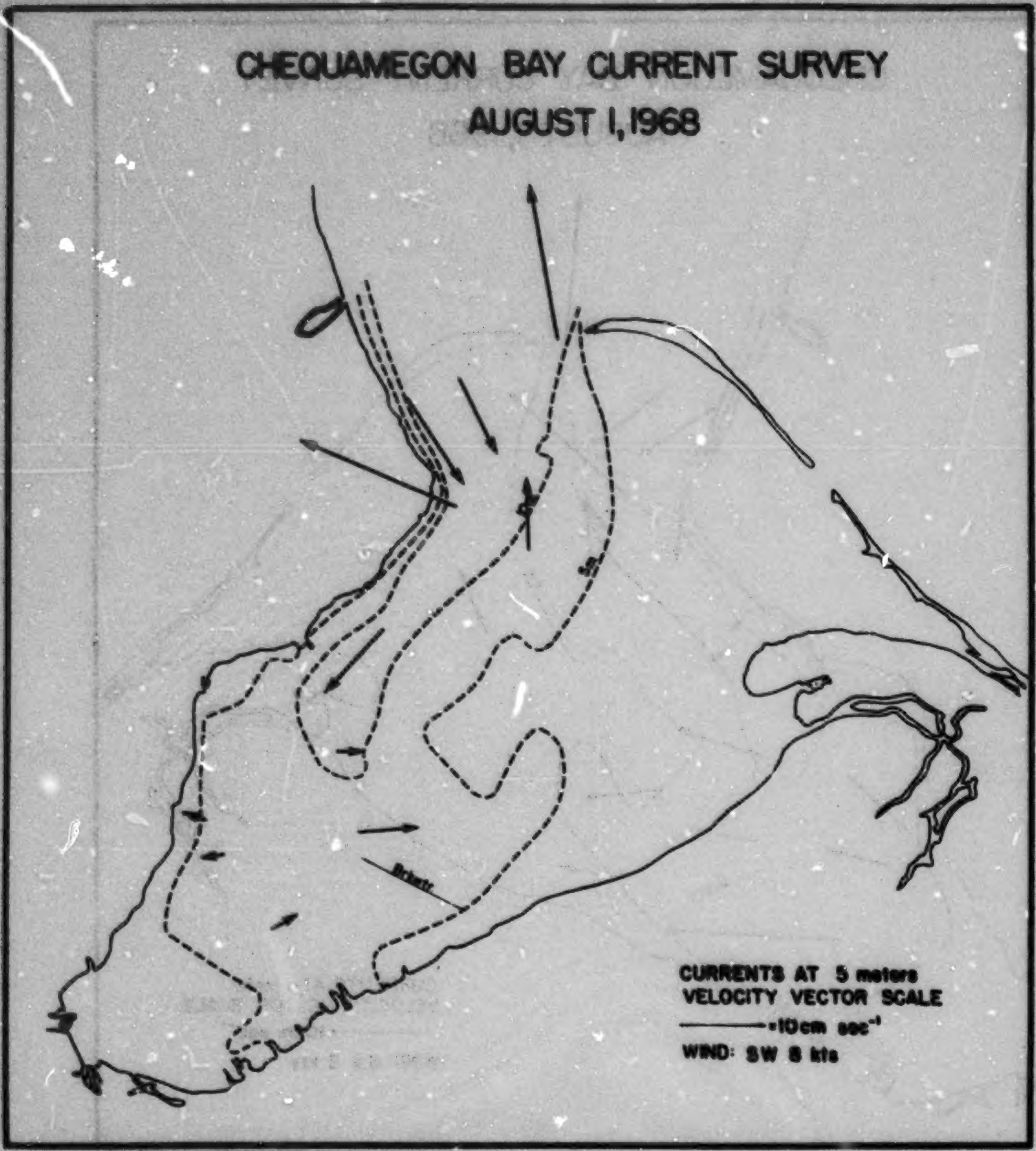


Figure 21. Results of survey of currents at five meters, made 1 August, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

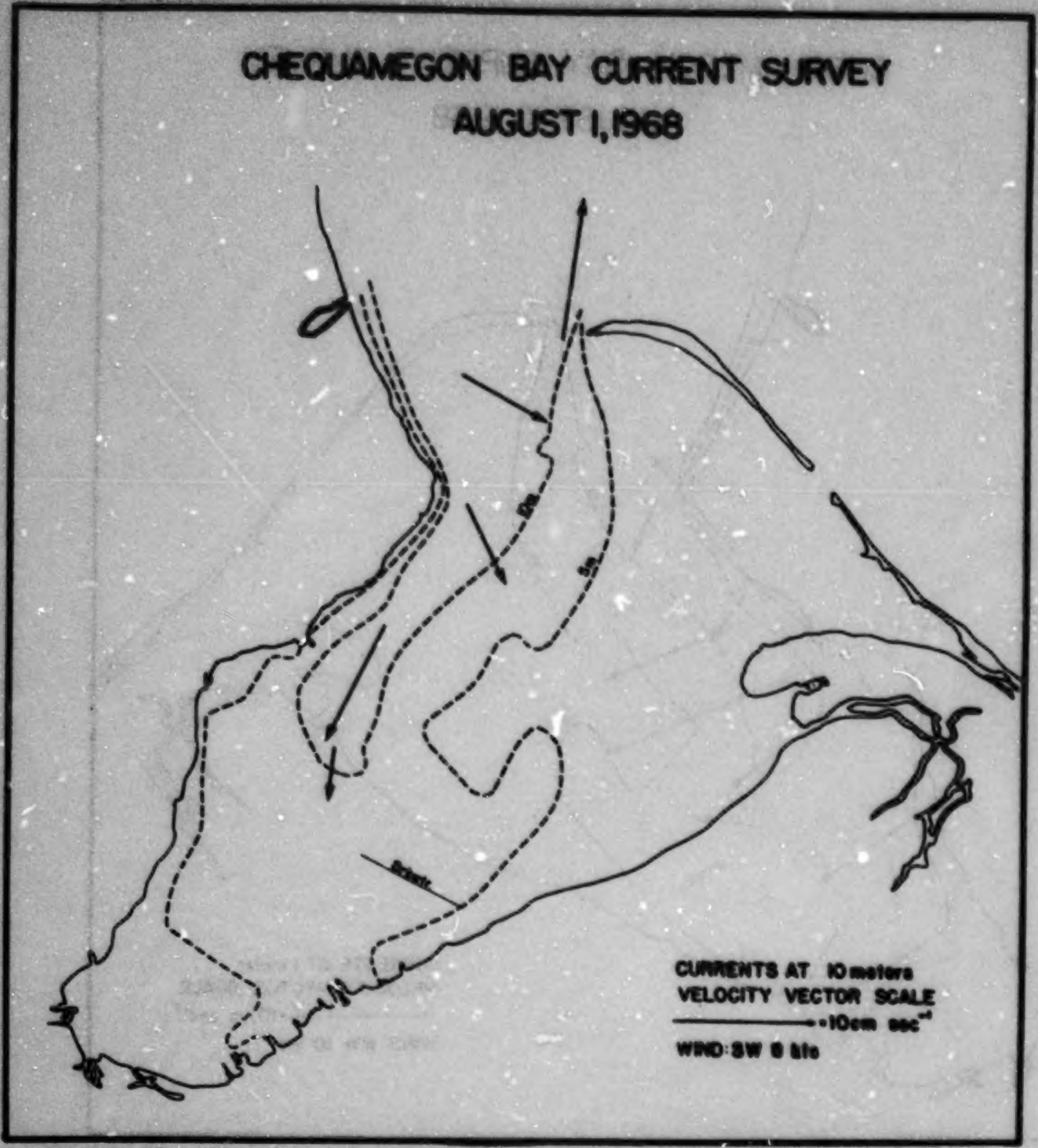


Figure 22. Results of survey of currents at ten meters, made 1 August, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

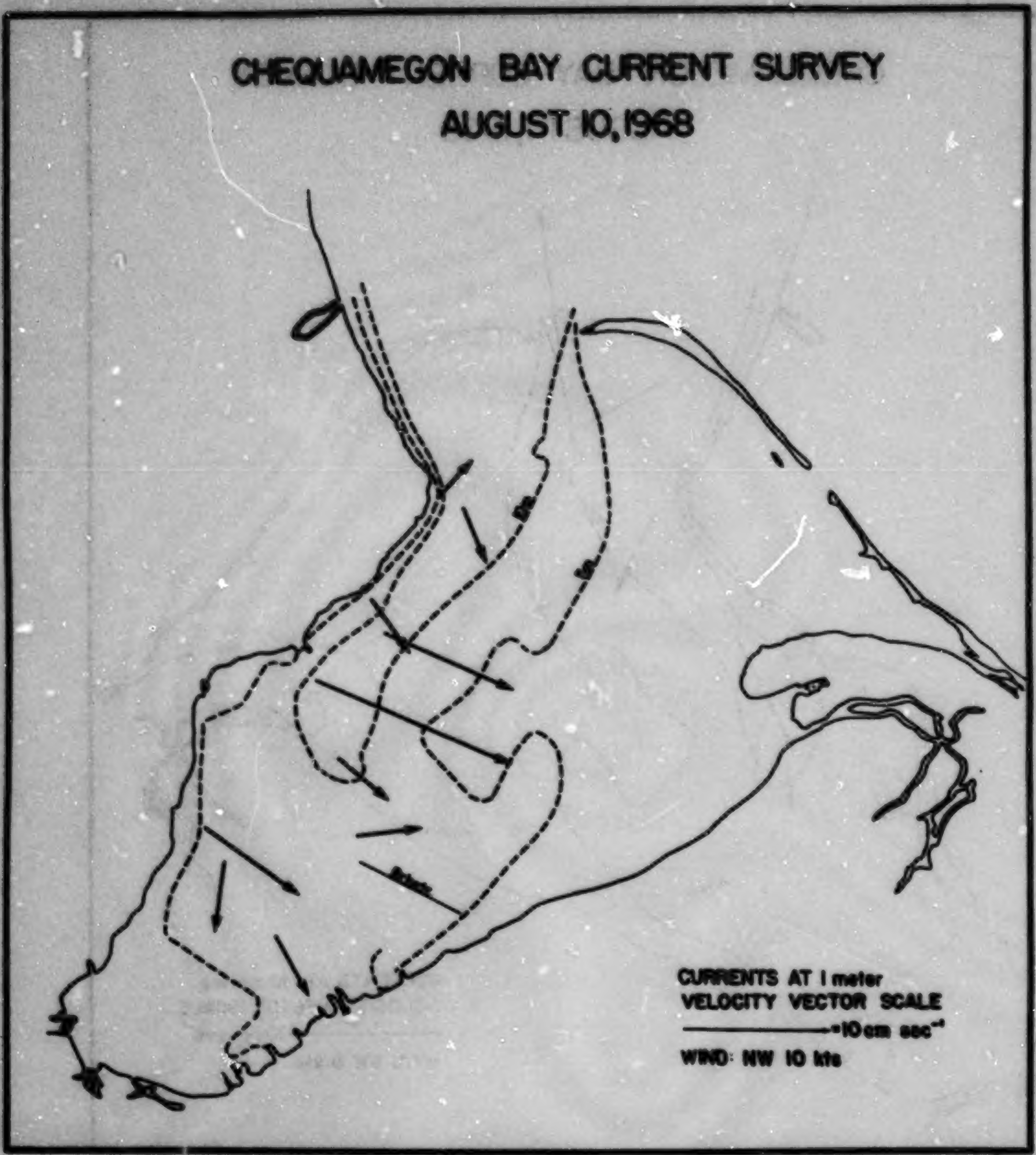


Figure 23. Results of survey of currents at one meter, made 10 August, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

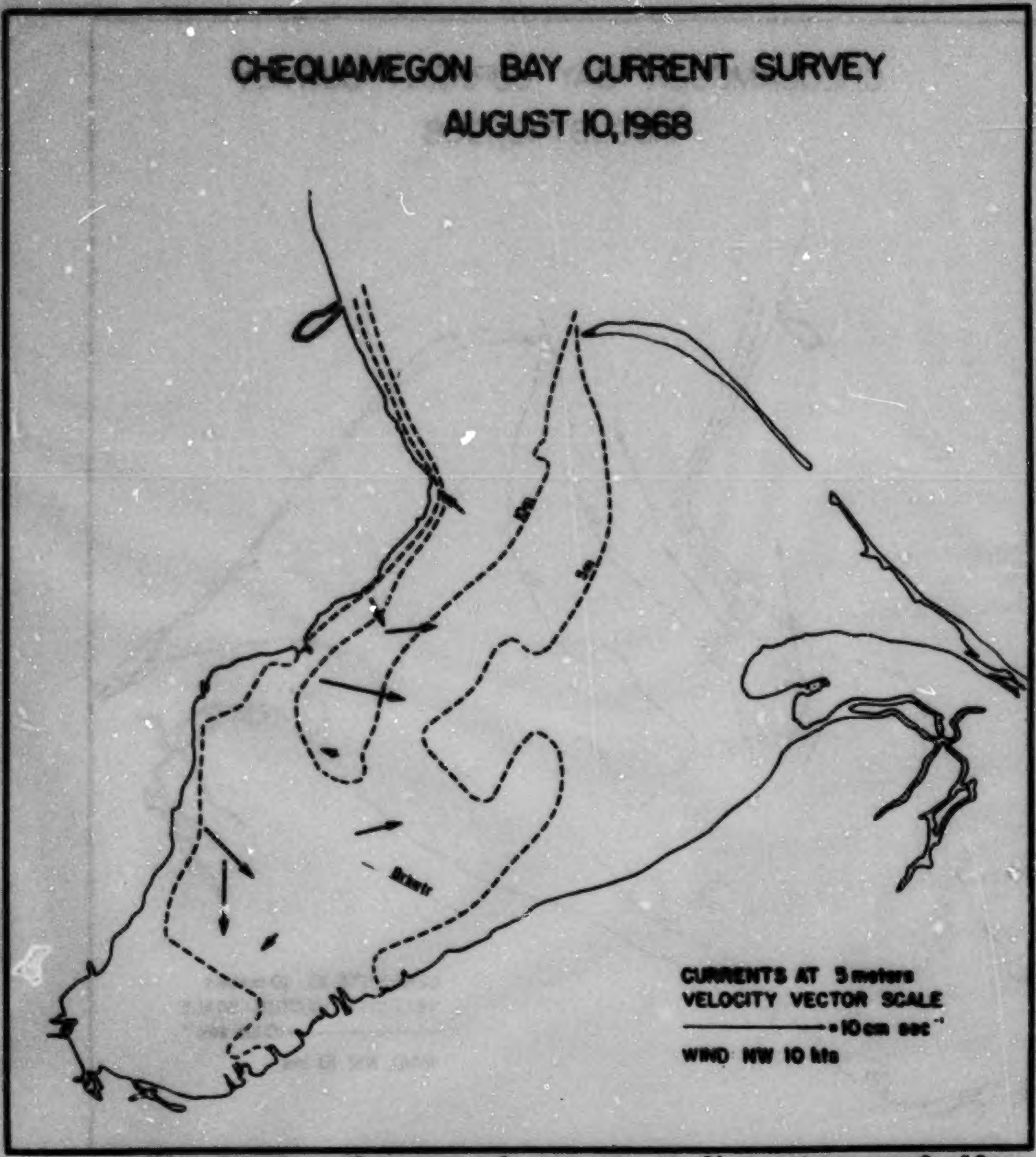


Figure 24. Results of survey of currents at five meters, made 10 August, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

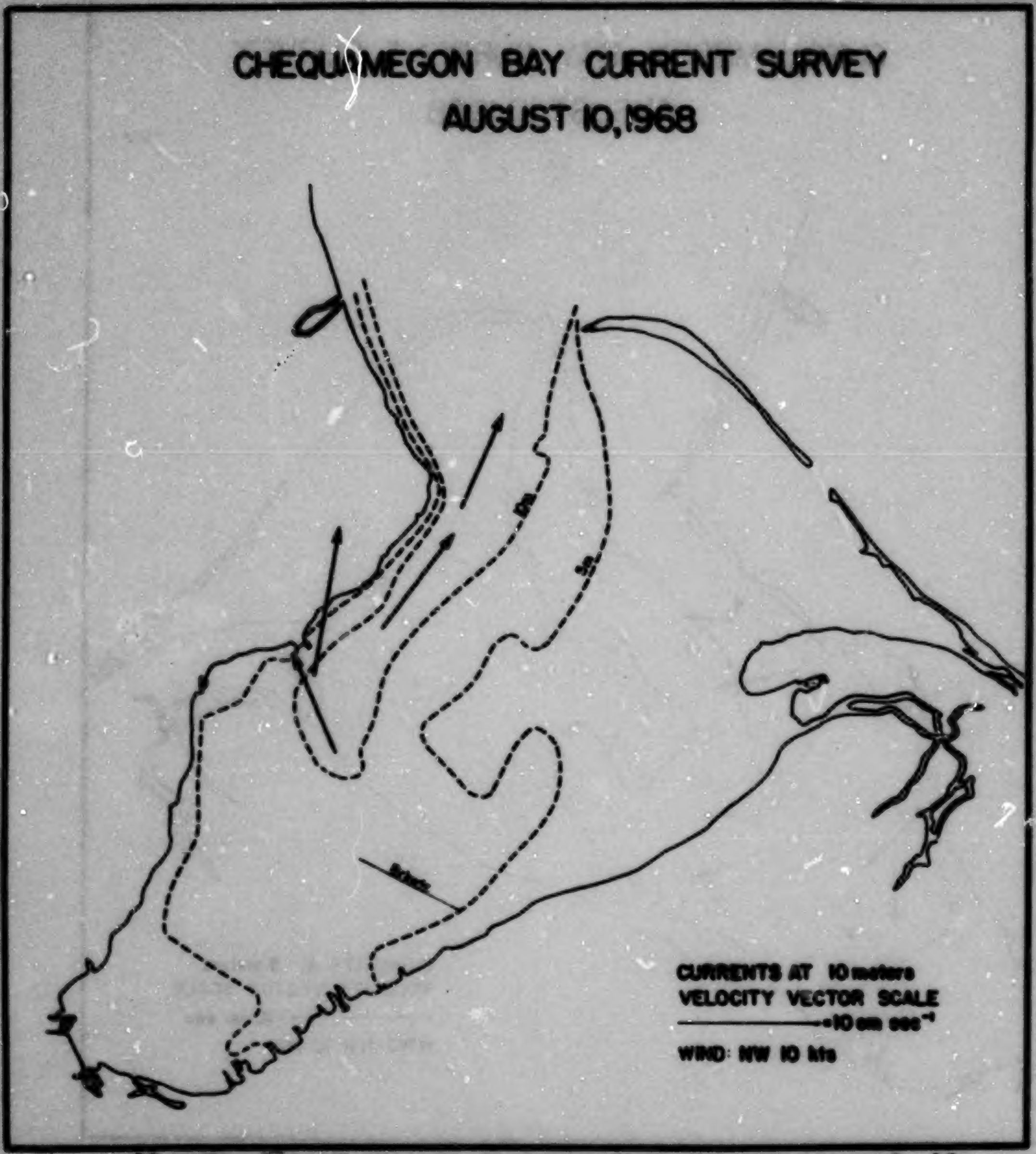


Figure 25. Results of survey of currents at ten meters, made 10 August, 1968. Vectors are positioned such that the base is at the measurement point and are oriented to indicate current direction with length of vector proportional to current speed. Dashed lines are bottom contours.

Results of the three time series of current measurements are shown in figures 26-28. Current velocities at selected depths are shown as functions of time. The vectors shown indicate both direction and speed as previously indicated.

IV. DYE TRACER EXPERIMENT

On 10 September 1968 a dye tracer experiment was conducted near station V-2 (Fig.3) using Rhodamine WT, a fluorescent dye with low sorption tendencies. The procedure was as follows: Twenty-five pounds of 20 percent Rhodamine WT in solution was released at a depth of seven meters which is one meter above the bottom. The movement and dispersion of the resulting dye cloud was observed by pumping the water to the surface and measuring the fluorescence with a Turner Fluorometer. With this instrument it is possible to measure fluorescent dye concentrations over a range of five orders of magnitude, and to a minimum of 0.1 parts per million.

On the day of the experiment the wind was out of the north at 10 to 12 knots in the morning and gradually decreased throughout the day. At 1000h CDT the water column was almost isothermal with a temperature gradient of 0.2°C from the surface to the bottom at eight meters. Four hours later at 1405h surface heating had increased the vertical temperature gradient slightly to 0.9°C from top to bottom. No pronounced thermocline was present at any time, and the water column could best be described as very weakly stratified.

Two attempts were made to carry out the experiment. The first dye release was made at 1000h. This experiment failed because the dye cloud was lost in the first few minutes. Shortly after this first release, a very small amount of dye appeared at the surface. This was most likely due to the method of release, namely by pumping the dye solution through a U-tube at the end of a rubber hose, which effectively jetted the dye

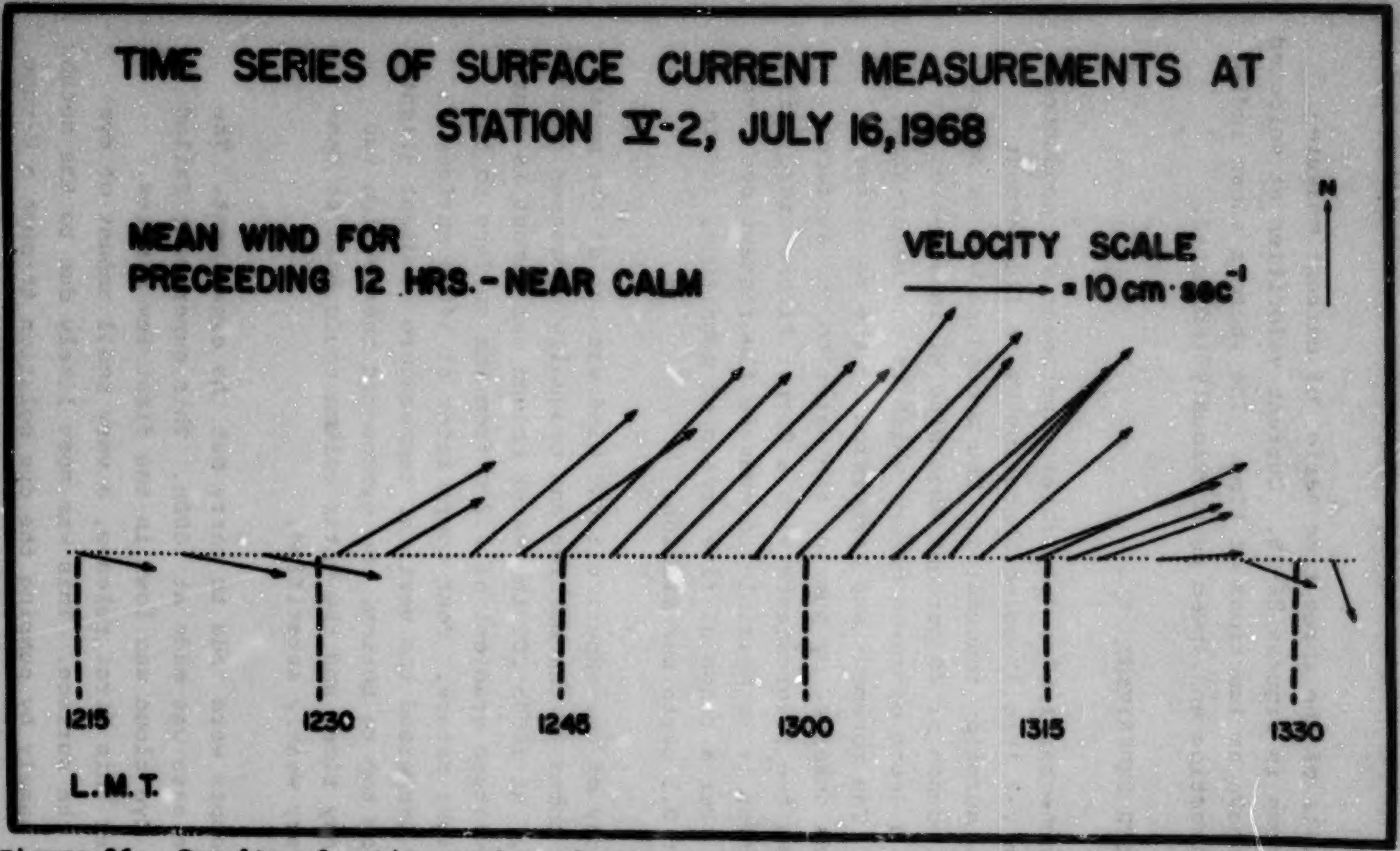


Figure 26. Results of a time series of current measurements made at Station V-2 on 16 July 1968. Vectors are positioned with the base of the vector at the time at which the measurement was made. Orientation of the vector indicates current direction and length of the vector is proportional to current speed. Wind indicated is from the records from the Bayfield Coast Guard Station.

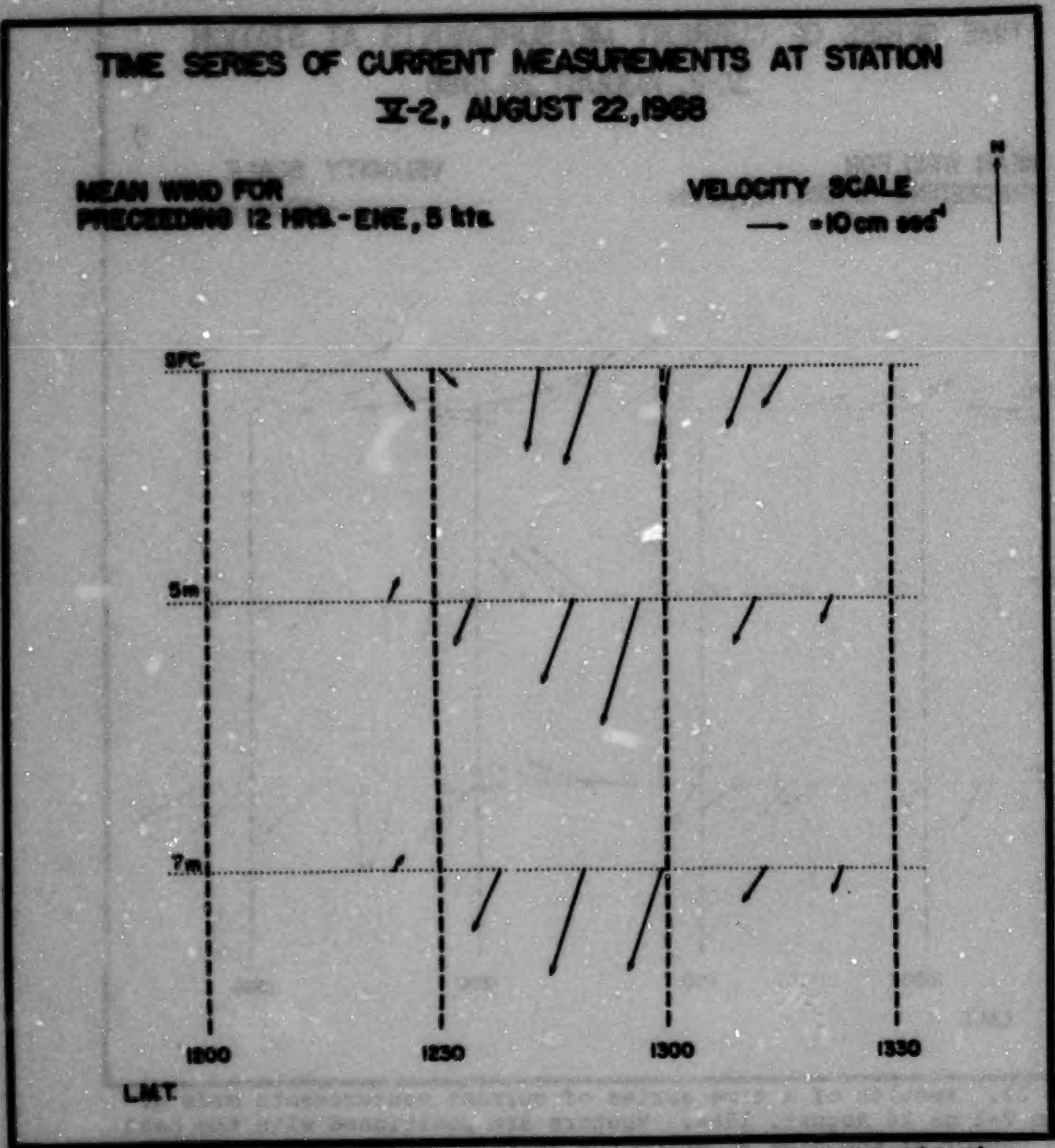


Figure 27. Results of a time series of current measurements at Station V-2 on 22 August 1968. Vectors are positioned with the base of the vector on the time at which the measurement was made. Orientation of the vector indicates current direction and length of the vector is proportional to current speed. Wind indicated is from the records of the Bayfield Coast Guard Station.

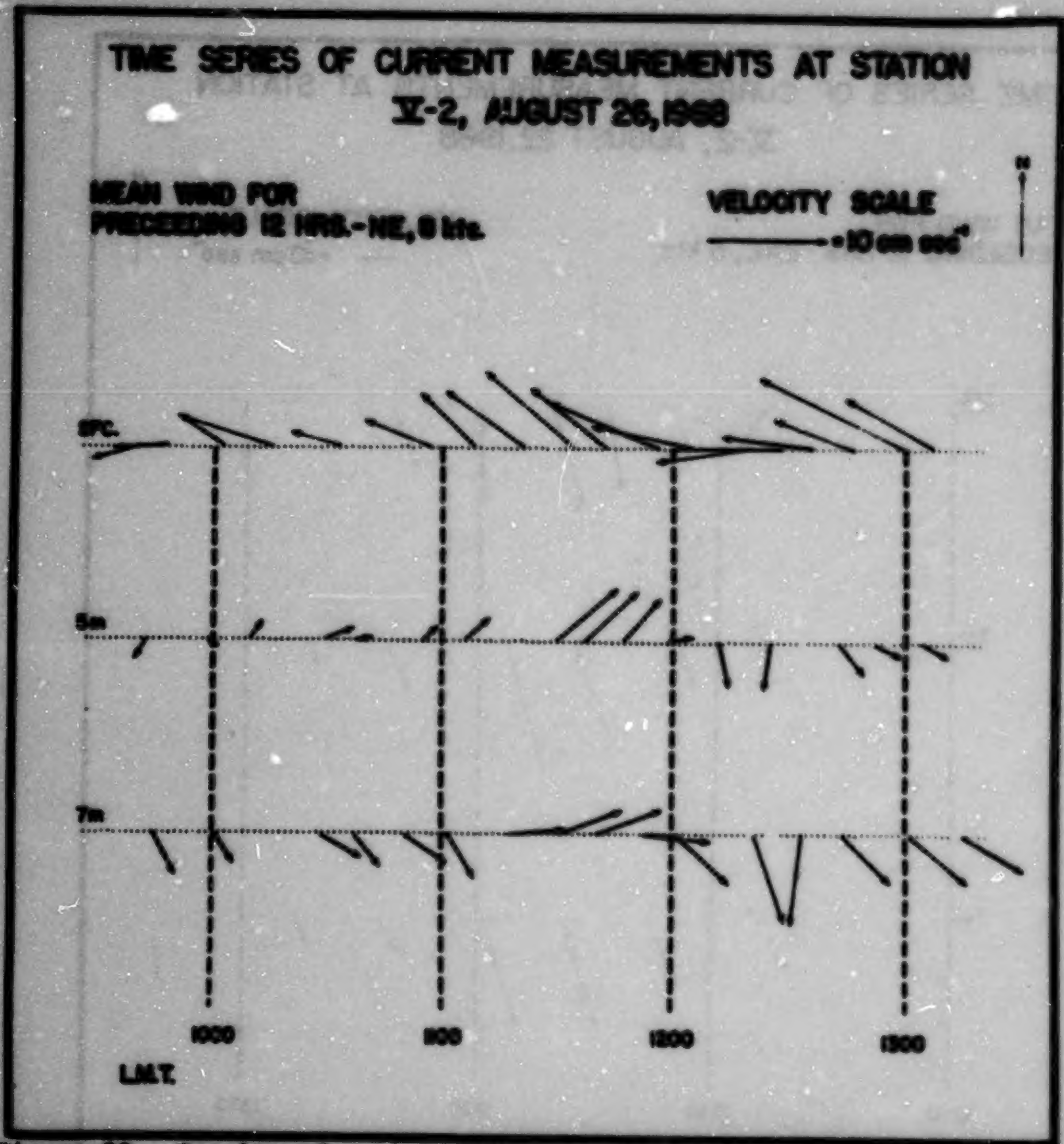


Figure 28. Results of a time series of current measurements made at Station V-2 on 26 August, 1968. Vectors are positioned with the base of the vector at the time at which the measurement was made. Orientation of the vector indicates current direction and length of the vector is proportional to current speed. Wind indicated is from the records of the Bayfield Coast Guard Station.

upward with sufficient force so that a small amount reached the surface. The surface cloud remained small however, and it was apparent that most of the dye stayed well below the surface and out of sight.

The second dye release was made at 1525h also at seven meters below the surface and one meter above the bottom. The terminal tube was aimed horizontally and the dye introduced over a period of about 10 minutes in order to enlarge the cloud. At no time during or following this second release did any dye approach close enough to the surface to be observed visually. The cloud was located and successfully followed by fluorometry until 1808h.

Current measurements with free drogues were made at the release point immediately subsequent to the release and again at the termination point at the end of the experiment.

The results of the tracer experiment and measured currents are shown in figures 29 and 30. In figure 29 a plan view and longitudinal section of the apparent trajectory of the dye cloud are shown on the same horizontal distance scale. The time lines indicate the estimated position of the leading edge of the cloud at 30 minute intervals. For each time interval conservative estimates of the velocity of the leading edge of the cloud are given in cm. sec^{-1} . The agreement between the estimated velocity of the dye and the current velocities measured by free drogues is excellent. Note that the dye, located between six and seven meters depth had an initial velocity of 3.6 cm. sec^{-1} while the drogue measurements gave velocities of 2.9 cm. sec^{-1}at five meters and 4.5 cm. sec^{-1} at seven meters or an average of 3.7 cm. sec^{-1}(Fig. 30). Similarly the dye at the end of the experiment, then located

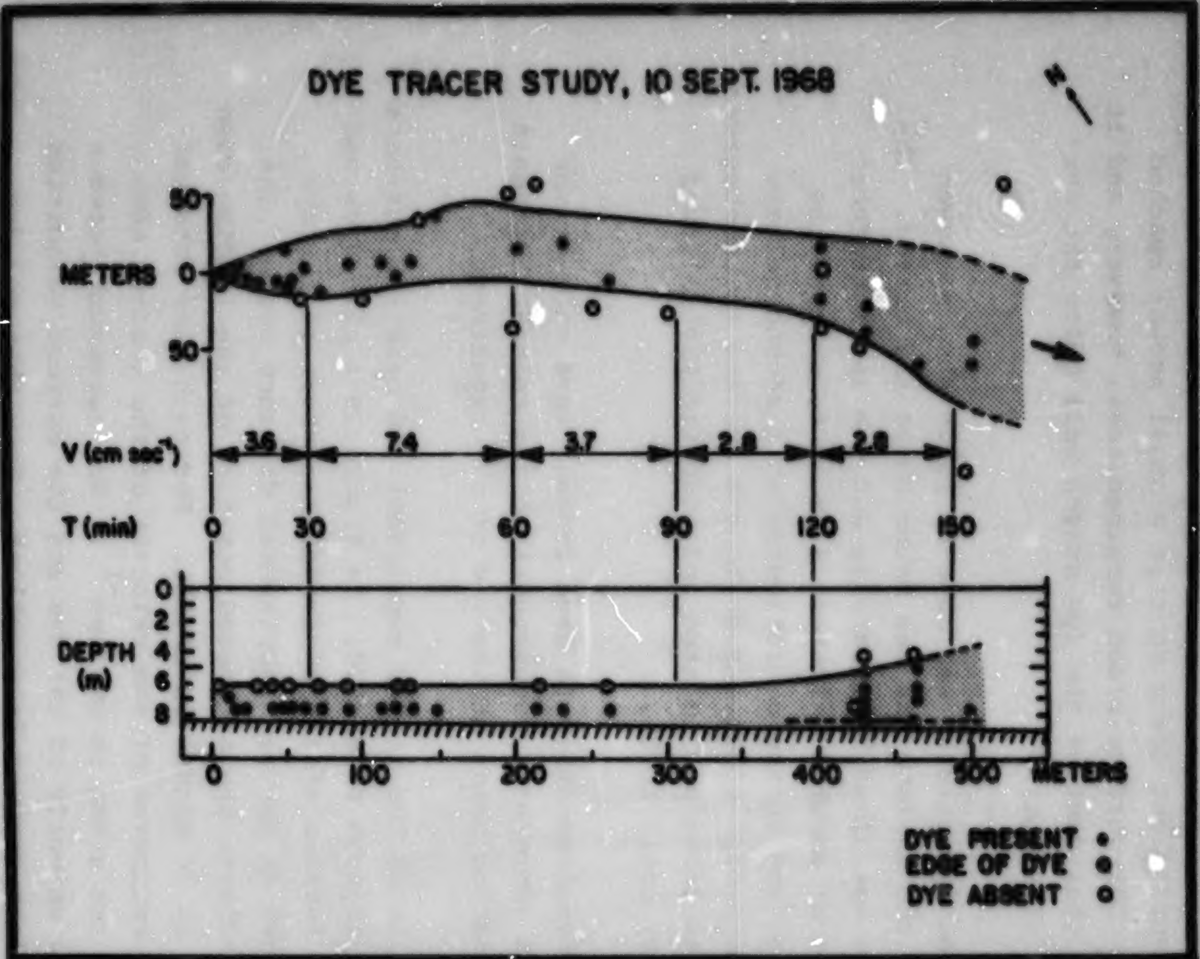


Figure 29. Plan view and vertical section of apparent trajectory of dye cloud released at station V-2 on 10 September 1968. Velocities shown are estimates (cm. sec^{-1}) based on position of the leading edge of the cloud. Time shown is time elapsed (minutes) after dye release.

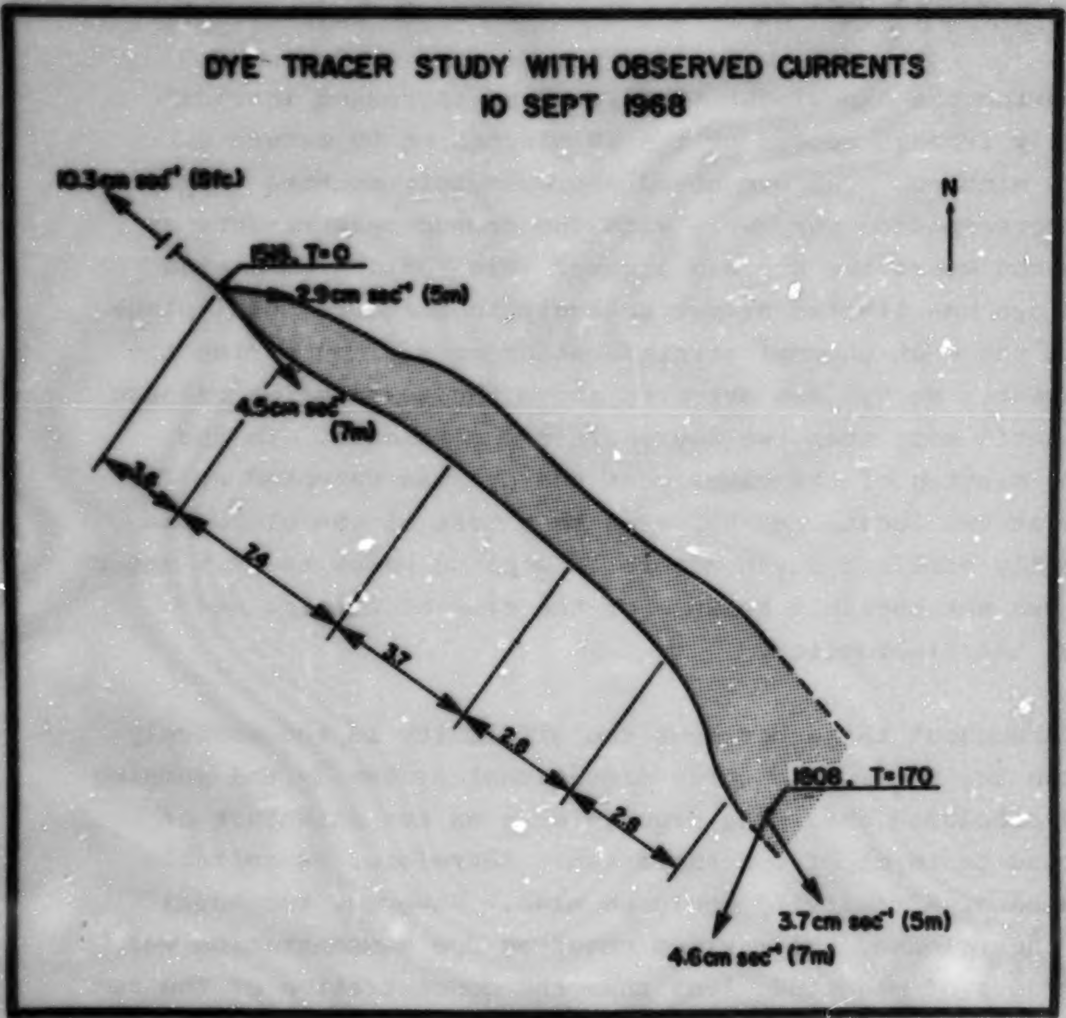


Figure 30. Plan view of trajectory of dye cloud with measured currents (cm. sec^{-1}) and cloud velocity (cm. sec^{-1}) estimated from dye tracer study, 10 September, 1968.

between five and seven meters was estimated to be moving at 2.8 cm. sec^{-1} and the drogue measurements gave velocities of 3.7 and 4.6 cm. sec^{-1} at five and seven meters respectively.

During the experiment the dye cloud increased in width gradually from 35 meters at t + 30 minutes to 90 meters at t + 150 minutes. The dye moved approximately southeastward which corresponded very well with the drogue measurements at the depths where the dye was located (Fig. 30). The mixing of the dye was limited almost entirely to the horizontal plane despite the weak thermal stratification prevailing during the experiment. No dye was detected above the seven meter release level until more than two hours after the release. In the last 45 minutes of the experiment the dye was detected at five meters at two locations, but even then most of the cloud was apparently still at seven meters. Sampling below the 7.5 meter level was not possible because of the risk of pumping mud through the Fluorometer.

Throughout the experiment the difficulty in successively locating the dye in the three dimensional system by the pumping method precluded obtaining precise data on the structure of the cloud in terms of concentration. Therefore, no reliable estimates of diffusivity could be made. However, two hours after the release, the maximum observed dye concentration was four orders of magnitude less than the concentration of the released solution.

From the results of the dye tracer experiment it can be concluded that:

1. Dissolved material introduced below the surface in Chequamegon Bay moves in the same direction and with the same speed as currents measured by the free drogue method, thus validating the use of free drogues for obtaining predictive data on water movements.

2. Vertical mixing in a weakly stratified situation (0.9°C per eight meters) with light wind action (less than 12 knots) is exceedingly weak.
3. Horizontal mixing under these same conditions is moderate with dilution through four orders of magnitude occurring in two hours.

V. DISCUSSION

A. General Comment

Chequamegon Bay is a semi-enclosed body of water connected at its northeast corner to Lake Superior by a passage between the mainland and Long Island. This passage is 4.5 km wide, with depths ranging to 23 meters. The bottom of the Bay slopes steadily downward along its long axis from the southwest to the northeast. There is no sill separating the Bay from the main body of Lake Superior.

The thermal and hydrographic behavior of Chequamegon Bay in summer can be generalized as a fluctuating system. The Bay behaves as a closed basin for periods of a few days, during which it undergoes surface heating and thermal stratification, and then under the influence of strong winds it is subjected to nearly complete flushing and exchange with the main body of Lake Superior. With a wind reversal, new surface water flows back into the Bay, the thermocline tends to reform and the cycle begins again. The entire cycle can be likened to the action of an estuary with the flushing effect of the tides except that the flushing is caused by aperiodic wind episodes.

The Bay is characterized by the presence of varying currents at all depths at all times. Of the (total no.) 251 currents measured during July and August, 1968, 28 percent had a speed greater than 10 cm. sec^{-1} and the mode speed was 5 cm. sec^{-1} (Table 3). Although these statistics in themselves

Table 3: Frequency Distribution of Observed Current Velocities at all Stations

Depth (M)	1		5		7		10		total		cumulative
Speed (cm·sec⁻¹)	no.	%	no.	%	no.	%	no.	%	no.	%	%
0 - 2.9	9	6.3	25	36.3	2	7.4	0	0	36	14.3	100.0
3 - 5.9	30	21.1	21	30.5	16	59.3	6	46.1	73	29.1	85.7
6 - 8.9	40	28.3	12	17.5	5	18.5	4	30.8	61	24.3	56.6
9 - 11.9	19	13.4	5	7.2	1	3.7	2	15.4	27	10.7	32.3
12 - 14.9	21	14.8	2	2.9	0	0.0	0	0.0	23	9.2	21.6
15 - 17.9	10	7.0	1	1.4	1	3.7	1	7.7	13	5.2	12.4
18 - 20.9	6	4.2	1	1.4	0	0.0	0	0.0	7	2.8	7.2
21 - 23.9	5	3.5	1	1.4	0	0.0	0	0.0	6	2.4	4.4
24 - 26.9	2	1.4	0	0.0	0	0.0	0	0.0	2	0.8	2.0
27 - 29.9	0	0.0	0	0.0	2	7.4	0	0.0	2	0.8	1.2
≥ 30.0	0	0.0	1	1.4	0	0.0	0	0.0	1	0.4	0.4

do not tell much about the pattern of the circulation, they are a measure of the vigor of the circulation which is primarily winddriven. Only once, at one station was a zero current observed.

Superimposed on the winddriven circulation and the occasional nearly complete flushing of the Bay is a continuous and complex oscillation of the water surface. This seiche activity, which is also winddriven, exhibits several frequencies which correspond well with those which would be expected on theoretical grounds (Table 1) with vertical displacements ranging from 5 to 75 centimeters (Table 2). These vertical displacements are necessarily accompanied by horizontal motions of the water which vary sinusoidally and reverse every half period. Since at least four waves with different periods are occurring simultaneously, the pattern of these seiche currents is extremely complex. When these are added to the directly winddriven currents the result is a highly variable current regime which is not always amenable to unambiguous analysis.

B. Thermal Evidence

The constantly changing thermal structure of the Bay provides the primary evidence for the apparent fluctuating behavior of the circulation. The time series of temperature measurements at stations V-2, IV-2, and I-2 as shown in figures 8 - 12 and the longitudinal temperature sections for 9 - 27 August (Figs. 13 - 16) illustrate very well the unsteady behavior of the thermal stratification.

As an example consider the two thermal cycles that occurred between 11 and 23 August. During the three day period 11 - 13 August the wind was from the southwest and the entire mass of water above the 18°C isotherm was swept northeastward and out of the Bay. This warm water was replaced by cool water flowing below. This water replacement process is shown in figures 8 - 10 and probably even more clearly by the longitudinal temperature sections in figures 13 - 14. Note that by 14 August no 18°C water was observed at any of the three stations while 8°C water had penetrated all the way to station V-2 and most of the Bay was dominated by water cooler than 16°C (Fig. 14).

During the next four days, 14 - 17 August, the wind was mostly north or northeast, i.e. into the Bay. The cool water apparently moved lakeward and although a small amount of 18°C water was observed on 16 August (Figure 14), the return flow in the upper levels was almost completely made up of water between 16°C and 18°C (Fig. 15).

On 18 and 19 August the wind was again from the southwest and cool water again intruded along the bottom forcing the 16°C isotherm upward as the warmer surface water moved lakeward. (Fig. 15). A wind reversal to the northeast on 21 - 23 August resulted in a second inflow of the warm surface water and consequent outflow of the deeper cool water, completing a second cycle.

These thermal cycles are clearly linked to the wind changes accompanying the passage of cyclonic storms every four to six days. The process is probably best viewed as a forced oscillation of the thermocline with cool sub-surface Lake Superior water penetrating deep into the Bay at intervals corresponding to the occurrence of prolonged southwest winds. The reciprocal flow of the warm water of the Bay probably represents a change of water of the Bay itself since the return flow of water in the upper layers associated with succeeding north-northeast winds is never quite as warm as the water that was swept out of the Bay by the previous southwest wind.

The amount of water exchanged between the Lake and the Bay during one of these cycles is of interest. If one assumes that there is no transverse variation in the thermal structure of the Bay, and that any change in water temperature is due to advection, it is possible to approximate the volume of the water movement necessary to cause the observed displacements of any isotherm. This was done by dividing the Bay into ten sections, each approximately perpendicular to the longitudinal axis of the Bay and each section was then divided vertically into one meter increments. The volume of water in each one meter increment of each section was computed. Using these volumes and the observed displacements of the 16°C isotherm, the following results were obtained. The rise of the 16°C isotherm in the period 10 - 14 August represents an inflow of bottom water equivalent to 51 percent of the volume of the Bay, with compensating outflow of surface water. During the period 14 - 18 August the downward movement of the 16°C isotherm represents outflow of bottom water equivalent to 55 percent of the volume of the Bay, with compensating inflow of surface water.

It is almost certain that the general eastward flow of the surface water of Lake Superior along the south shore (Ragotzkie and Bratnick, 1965; Ragotzkie, 1966; Monohan, 1968) entrains surface water "exhaled" from the Bay and provides new water for the succeeding "inhalation." In this way most of the water in the Bay is replaced more or less regularly by the reversing wind regimes characteristic of the cyclonic storms of this region.

C. Direct Measurements of Currents

In the previous section the mean motions of the water masses of the entire Bay are deduced from the observed fluctuations of the thermal structure. Direct measurements of the currents would not be expected to reveal a clear picture of these mean motions because of the high variability of individual currents both in space and in time due to geometry of the Bay and short term fluctuations of the wind. This variability is further increased by the complex horizontal motions resulting from the multiple seiche activity. Nevertheless, some features of the circulation of the Bay can be elucidated from the current data.

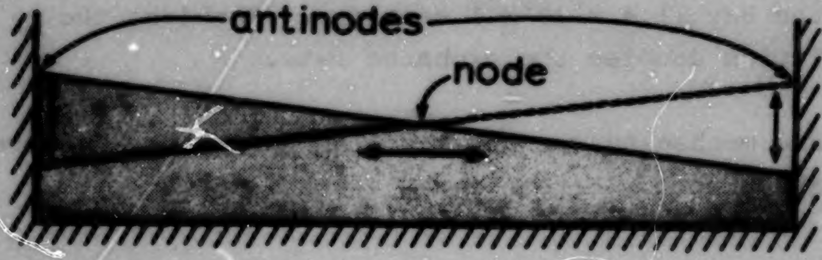
Beginning with the one-meter currents (labelled "surface" in the figures) it can be seen that as expected the surface water tends to move in the direction of the wind or slightly to the right of the wind as predicted by the Ekman theory (Figs. 18, 20, and 23). This is consonant with the general lakeward movement under southwest winds and the reverse on north and northeast winds described in the previous section.

The currents at five meters depth (Figs. 19, 21, and 24) strongly suggest a systematic counter-clockwise circulation at this depth. In addition to the current vectors shown in these figures the position of the five-meter depth contour should be examined. Horizontal currents at five meters will tend to be parallel to this contour and the observed current mostly confirms this. Thus the water at five meters tends to enter the Bay along the west shore, circle counterclockwise parallel to the five-meter contour and leave the Bay on the east side.

At 10 meters the Bay is reduced to a relatively narrow channel along the west shore. The current appears to be directed either into or out of the Bay (Figs. 22 and 25) although on 1 August (Fig. 22) there was some tendency for a counterclockwise turning in the vicinity of section I. The direction of the 10 meter current was generally opposite to the wind indicating that deeper water was replacing surface water swept out of the Bay by southwest winds (Fig. 22) or that deeper water was being forced out of the Bay by the influx of surface water under northwest winds (Fig. 25). This two-layered model is further confirmed by the analysis of the thermal structure in the previous section.

D. Significance of Seiches

As previously pointed out, the horizontal motions deriving from the multiple seiche activity are complex. For the primary uninodal seiche with a period of 60 - 65 minutes the maximum horizontal current at the nodal line is calculated to range from 8 to 27 cm. sec^{-1} for the most frequent seiche amplitudes of 10 to 35 cm. Note that these are maximum currents which would occur at the nodal line as the surface of the Bay passes through the horizontal position. Away from the node the maximum currents decrease, reaching zero at the antinodes where only vertical motion occurs (see diagram below).



Seiche currents are sinusoidal in character, reversing every half period. Because of this, these currents by themselves do not result in any net transport of water. However, by providing a back and forth sloshing of the water they can be expected to enhance mixing processes, and when a gradient of any constituent exists, the oscillatory motion plus mixing will result in net movement of the constituent in the direction of the gradient from higher to lower concentration.

The 140 minute seiche is a special case. A first order calculation of the wavelength of this seiche indicates that the nodal line lies somewhere near the mouth of Chequamegon Bay. An oscillating horizontal motion induced by this seiche across the nodal line will result in transport of water in and out of the Bay itself. As water moves out of the Bay it can be expected to be entrained in steady lake currents flowing past the Bay, usually eastward along the south shore of Lake Superior (Ragotzkie, Bratnick, 1965; Ragotzkie, 1966). Then when the return flow occurs across the nodal line, new water will flow into the Bay. In this way, a regular flushing action occurs with a period of about 140 minutes. A first order approximation of the exchange rate was calculated assuming that the surface of the Bay remains a plane. The results (Table 4) indicate that a 10 cm. vertical oscillation could result in an exchange rate of 5 percent of the volume of the Bay (1.4 x $10^9 M^3$) each day. Doubling the vertical oscillation doubles the exchange rate.

This same mechanism was observed and documented for Great South Bay in Lake Huron by Bryson and Stearns (1959).

Table 4. Flushing rate due to seiche with nodal line across mouth of Chequamegon Bay.

Range (cm.) of vertical displacement at SW end of Bay	Flushing Rate	
	percent of total volume per cycle (140 min.)	percent of total volume per day
5	0.25	2.5
10	0.5	5.1
20	1.0	10.3

The oscillatory nature of seiche currents superimposed on the winddriven currents result in an increased variability in the observed currents. Figures 26 - 28 clearly show this effect. At station V-2 on 16 July a series of current measurements at one meter (labelled "surface" in Fig. 26) indicate a regular variation in the current with an approximate period of 60 minutes suggesting that the uninodal seiche current is interacting with the steadier winddriven current. Figure 27 shows a similar effect at the same station on 22 August at one, five and seven meters. On 26 August (Fig. 28) the current fluctuations appear to have a period of slightly more than two hours suggesting that the 140 minute seiche is dominant.

Note that the variation in currents is in terms of both speed and direction, but seldom does the current reverse completely. This would only be expected if the maximum seiche current exceeded the winddriven current, and this would be most likely to occur at or near the nodal line when the seiche was particularly active. However, an increase in seiche amplitude and hence in seiche currents is associated with strong winds, and since this would also favor faster winddriven currents, dominance of seiche currents would not normally be expected. Therefore the conclusions drawn from the observed currents are not necessarily invalidated by the interference of seiche-induced currents although interpretation is frequently more difficult due to the complexity of the interaction of the two kinds of motion.

The significance of seiche currents is in the enhancement of mixing and the interaction of seiche currents with steady currents flowing past a bay. Seiche currents are superimposed on winddriven currents and thereby increase the variability of observed currents, but seldom dominating the field of horizontal motion.

E. Circulation During other Seasons

During spring immediately after the ice goes out and late fall until complete ice cover forms the Bay can be expected to be isothermal, i.e. unstratified. Under these conditions complete vertical mixing of the water occurs. Although no observations were made during these periods, some comment on the nature of the circulation can be made based on the behavior of other water bodies in this region.

In spring the ice normally leaves Chequamegon Bay sometime in May. At this time solar radiation is approaching its maximum and surface heating of the water is fairly rapid. A shallow thermocline can be expected to form in a matter of a few days. This thermocline may be broken up by a strong wind, only to form again a few days later. Within two or three weeks a permanent thermocline will form which then gradually migrates downward under the influence of occasional strong wind action and further solar heating. In 1968 the permanent thermocline had formed before 4 June when surface water temperatures of 16° to 20°C were observed in the southern half of the Bay by means of an airborne infrared radiometer (Fig. 31). The results of the present study are applicable whenever the Bay is stratified.

The isothermal situation in late fall results from a combination of surface cooling and wind action. Surface cooling will tend to weaken the hydrostatic stability of the water column until the mixing action of the wind exceeds the damping action of the stability, resulting in complete vertical mixing. Since cooling is continuous until ice cover forms, the isothermal situation will prevail until freeze-up. During this period circulation is likely to be more vigorous than during the summer. This comes about for two reasons: First, the water is warmer than the air and the resulting instability of the air over the water results in much enhanced "coupling" between the atmosphere and the water. More kinetic energy is transferred to the water

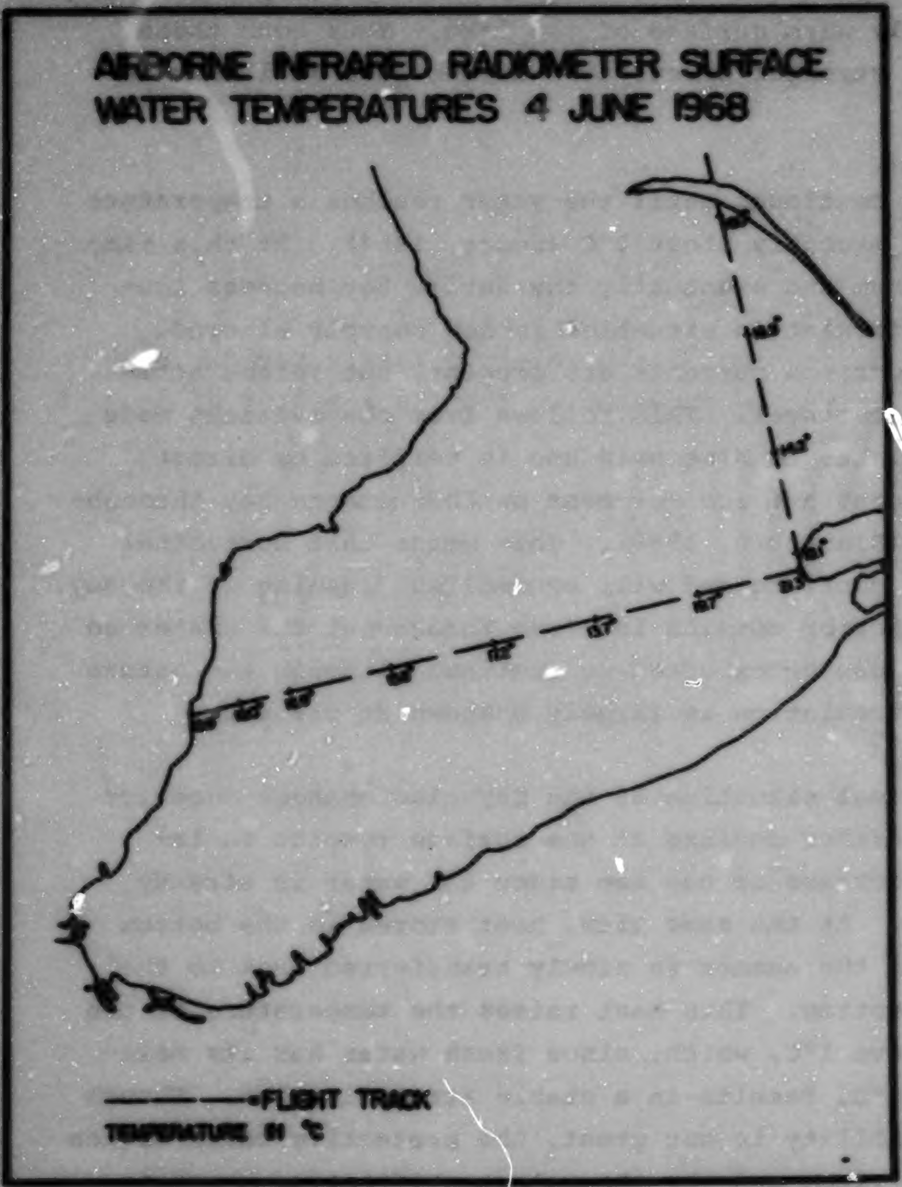

AIRBORNE INFRARED RADIOMETER SURFACE WATER TEMPERATURES 4 JUNE 1968
FLIGHT TRACK
TEMPERATURE IN °C

Figure 31. Surface water temperature from airborne radiometer measurements, 4 June 1968.

and higher current velocities and more vigorous mixing can be expected. Second, wind velocities in the late fall are frequently higher due to the passage of early winter cyclonic storms. These storms tend to intensify over Lake Superior due to the relatively warm surface of the lake. Thus both these factors favor a stronger circulation during late fall than in the summer.

Cooling continues until the water reaches a temperature well below 4°C, probably about 1°C (Scott, 1964). At this time ice starts to form and eventually the entire Bay becomes ice-covered. The circulation situation is now sharply altered. No directly winddriven currents are present, but seiche activity certainly continues. This follows from observations made on ice-covered lakes in Wisconsin and is verified by direct observation of constant ice movement on Chequamegon Bay throughout the winter (Blackburn, 1968). This means that horizontal seiche currents continue and will accomplish flushing of the Bay. Much of Lake Superior remains ice-free throughout the winter so its circulation can be expected to continue although the nature of its winter circulation is largely unknown at present.

The thermal situation of the Bay also changes once ice cover forms. Further cooling at the surface results in increasing the thickness of the ice since the water is already at or below 1°C. At the same time, heat stored in the bottom sediments during the summer is slowly transferred back to the water near the bottom. This heat raises the temperature of the bottom water above 1°C, which, since fresh water has its maximum density at 4°C, results in a stable stratification. Though the absolute stability is not great, the protective cover of ice prevents wind mixing, and the thermal stratification persists and increases throughout the ice season.

VI. CONCLUSIONS

1. Chequamegon Bay is dominated by a wind-induced circulation which is expressed partly as directly wind-driven currents and partly as a complex oscillation (seiche) of the Bay as a whole.

2. The Bay is thermally stratified during the summer season, at least from early June to early September.

3. Exchange of water between the Bay and Lake Superior occurs by a forced fluctuation of the thermocline. Sustained southwesterly winds result in the removal of warm surface water and replacement from below by cooler sub-surface water from Lake Superior. Northerly winds result in the opposite circulation with surface Lake Superior water entering the bay and sub-surface water of the Bay leaving. These reversals characteristically occur every five to ten days depending on the frequency of cyclonic storms.

4. Seiche activity is expressed by multiple oscillations of the Bay surface with periods of 12, 21, 36, 62, and 140 minutes. Horizontal currents associated with these oscillations are superimposed on the directly winddriven currents.

5. The 140-minute seiche has a nodal line near the mouth of the Bay and horizontal seiche currents across this line act as a flushing mechanism for the Bay.

6. A dye tracer experiment indicated that
   a. Dissolved material introduced below the surface in Chequamegon Bay moves in the same direction and with the same speed as currents measured by the free drogue method, thus validating the use of free drogues for obtaining predictive data on water movements.
   b. Vertical mixing in a weakly stratified situation (0.9° per eight meters) with light wind action (less than 12 knots) is exceedingly weak.

c. Horizontal mixing under these same conditions is moderate with diluation through four orders of magnitude occurring in two hours.

7. The water of Chequamegon Bay is in free circulation with Lake Superior and is flushed by at least two mechanisms: first, by the wind-induced fluctuations of the thermocline, and second, by the periodic motions associated with the seiche. First order calculations of the magnitude of the flushing rate by each of these mechanisms indicate that an exchange rate of 5 to 10 percent perday of the volume of the Bay with the Lake is not unusual.

8. Immediately after the break-up of the ice in the spring the Bay will be isothermal, i.e. unstratified, for a brief period during which both horizontal and vertical mixing will occur.

9. In the late fall isothermal conditions will again prevail. However during this part of the year the mixing and circulation will be stronger than in the summer due to increased wind action. As a consequence of this increased circulation, the flushing of the Bay can be expected to be more efficient.

10. During the period when the Bay is ice-covered, seiche currents can be expected to continue and interaction with Lake Superior will accomplish steady flushing. Weak thermal stratification probably prevails during this period, thus damping vertical mixing. Horizontal dispersion and movements will continue due to the seiche currents and circulation induced by thermal differences and by the interaction with Lake Superior.

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Lloyd L. Falk

A scientific paper on this work was presented last week by the Marine Center scientists at the Twelfth Conference on Great Lakes Reserach held in Ann Arbor, Michigan. The University study developed several pertinent items that should be of interest to this conference. In summary, these are:

1. The currents in Chequamegon Bay are caused partly by the wind and partly by the complex oscillations, called seiches, of the bay and Lake Superior.

2. Although one has the impression from a map that the bay is almost land-locked, there are great exchanges of water between the bay and the lake. It freely exchanges water with Lake Superior by wind currents as well as by seiche currents. For example, southerly winds push warm surface bay waters out into the lake, allowing cool bottom lake water to enter the bay. With northerly winds, the opposite effect takes place. Furthermore, west-to-east lake currents sweep away waters "exhaled" from the bay.

3. The report indicates that the exchange rate of the bay with the lake is more than 10 percent of the bay's volume per day. Since the bay's volume is about 400 billion gallons, this represents an average exchange rate with Lake Superior of over 27 million gallons per minute. This is equivalent, to give you a comparison, to about 1/3 the flow that goes over Niagara Falls.

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4. The bay waters are almost always in motion at all depths, due either to wind or seiche effects. Furthermore, these currents are always changing in direction as well as velocity. In other words, while there may be thermal stratification of the bay in summer, the deep, as well as shallow, waters do not stagnate. Even in winter when there is an ice cover, the university report indicates that the seiche currents still keep the bay waters in motion.

The Marine Studies Center Work showed us that "red water" will receive very great dilution in Chequamegon Bay. Discharge to deeper waters will not result in buildup of waste concentrations. No detrimental effects to other water uses will occur. But there will be elimination of the aesthetic color problem.

We are now working on the design of an effective dispersion system. This system will carry the wastes out into the bay over 1/2 mile from shore where the water depth is at least 20 feet. We shall jet the wastes at high velocity horizontally into these waters through nozzles less than one inch in diameter, spaced 50 feet apart. Using the well-established jet mixing formulas, we expect to get over 200 dilutions of our wastes within 35 feet of the end of the nozzles. Additional dilution will then occur as demonstrated by dye tracer tests carried out by the University last summer.

Our system will eliminate the coloration problem now existing along the shoreline. It will not create a new color problem further out because the initial mixing will be very rapid and the water depths will allow much more rapid mixing by the currents in the bay than is now the case near shore. "Red water" will not accumulate in the bay because of the constant motions of its waters and its high rate of exchange with Lake Superior.

The system we propose is within the policies of the Wisconsin Department of Natural Resources and will meet our obligations to provide adequate waste disposal under the water quality standards adopted by Wisconsin and approved by the Secretary of the Interior.

Thank you, Mr. Chairman.

(Applause.)

MR. DOMINICK: I believe we have a question.

MR. STEIN: I want to refer to your last statement. Here just what you are proposing is a dispersal system, and the last paragraph says:

> "The system we propose is within the policies of the Wisconsin Department of Natural Resources and will meet our obligations to provide adequate waste disposal under the water quality standards adopted by Wisconsin and approved by the Secretary of the Interior."

I don't want to pre-judge this, as I think you will have to work with our technical people, but this is a relatively positive statement that you are making and I just want to tag that for the purpose of the record. We will have to have discussions with our technical people before we can give you a judgment on that, at least from the Federal point of view.

MR. DOMINICK: Are there any other questions?

(No response.)

MR. DOMINICK: Thank you.

MR. FRANGOS: Mr. Chairman, I believe we have a representative from the Wisconsin Chapter of the Sierra Club. May we have that statement.

STATEMENT OF MRS. ROBERT G. ERICKSON,
REPRESENTATIVE, JOHN MUIR CHAPTER,
SIERRA CLUB, RACINE, WISCONSIN.

MRS. ERICKSON: I am Mrs. Robert G. Erickson of Racine, Wisconsin.

The John Muir Chapter of the Sierra Club, an organization of approximately 600 members, which is the Wisconsin unit of a national association of some 70,000 members, respectfully represents:

1. That the preservation of Lake Superior assumes critical importance in view of the fact that it is the last of the Great Lakes to remain in a "healthy" condition;

2. That protection of our remaining clean waters has such momentous significance insofar as the quality of life in this area is concerned that it must transcend matters of purely economic concern;

3. That studies by the Department of the Interior leave no doubt that the discharge of taconite tailings into this lake by Reserve Mining Company is causing pollution which results in increased turbidity, accelerated eutrophication, change in the chemical constitution of the water, and impairment of the fish habitat;

4. That it is completely illogical and utterly unconscionable to use this precious resource belonging to all of the people as a dumping ground for industrial wastes, especially in view of the fact that alternate methods of disposal are available and are used by other miners in the same industry;

5. That residents of the State of Wisconsin have a substantial interest in preservation of this lake because a sizable portion of their State borders on it and the attractiveness of the Apostle Islands and the proposed Apostle Islands National Lakeshore is dependent, to a large extent, upon maintenance of the purity of its waters.

Therefore, the John Muir Chapter of the Sierra Club urgently requests that the permit of the U. S. Army Corps of Engineers to the Reserve Mining Company be extended only on a conditional basis for a period of not to exceed 3 years and that use of the lake as a disposal site for taconite tailings be discontinued just as soon as alternate waste disposal facilities, including provision for recycling of washwater, can be arranged.

In addition, I would like to make one statement. I was most pleased to hear about the fine projects which the Reserve Mining Company has been doing in its local community in Minnesota. Just as advertising is one of the costs of their doing business, and just as these community projects are one of their costs of doing business, I feel that the cost of pollution should be considered in a like manner, a real cost of doing business.

Thank you very much.

(Applause.)

MR. FRANGOS: Thank you, Mrs. Erickson.

I now have a resolution received from the Wisconsin State Division of the Izaak Walton League of America.

> WHEREAS: the dumping of taconite tailings into Silver Bay has continued for a number of years past, and
>
> WHEREAS: this practice has produced unmistakable pollution of the Silver Bay area, and
>
> WHEREAS: other changes have appeared in water flow and in the ecology of the water life and food chain, and
>
> WHEREAS: said Silver Bay area is a part of Lake Superior, one of our greatest irreplaceable natural resources, and of inestimable value to the human family, and
>
> WHEREAS: the careless attitude of those who regard dumping their refuse into any natural resource as their right and privilege with no thought of any consequence, present or future, will no longer be tolerated by a long-suffering people

Miriam G. Dahl

deprived of their natural heritage through selfish misuse, nor should it be tolerated in this enlightened time with its great scientific expertise,

THEREFORE, BE IT RESOLVED: that the Wisconsin State Division of the Izaak Walton League of American favors and strongly urges the companies now dumping tailings, or any materials, or substance into Lake Superior, to cease and desist from this practice, and to return the residue from the taconite manufacture back into the ground from which it was taken, and further urge that proper disposition be made by anyone dumping any type of substance into any part of these waters, and

BE IT FURTHER RESOLVED THAT: the Wisconsin State Division of the Izaak Walton League of America urges that strong legislation be passed without delay and with powers of implementation to prevent any future use of Lake Superior or any of the Great Lakes including the watersheds drainage areas of these lakes, for purposes of dumping waste and refuse of any type by any company, municipality, or individuals, and, FURTHER, that these laws be clearly worded to be effectively enacted within the shortest possible time from now.

BE IT FURTHER RESOLVED THAT: Copies of this resolution be sent to Mr. Thomas Frangos, Director of the Wisconsin State Division for Environmental Protection to be presented at the hearing held by the Federal Water Pollution Control Board on May 13-14, 1969, at the Hotel Duluth, Duluth, Minnesota, and, further, that copies be sent to each Wisconsin Chapter of the Izaak Walton League of American and to the National Office in Glenview and to the press.

Respectfully submitted, Miriam G. Dahl, Chairman, Pollution Committee, Wisconsin State Division IWLA.

We now have a statement, Mr. Chairman, from Mr. Martin Hanson for the Wisconsin Resource Conservation Council.

STATEMENT OF MARTIN HANSON,
SECRETARY, WISCONSIN RESOURCE
CONSERVATION COUNCIL, MELLEN, WISCONSIN

MR. HANSON: My name is Martin Hanson, Secretary of the Wisconsin Resource Conservation Council, which is composed of about 35 affiliated groups concerned with the proper use of our natural resources.

The Council, at general membership meetings, has consistently urged that this Federal conference be held. We feel that States have been lagging and it is necessary for the Federal Government to see that antipollution measures are carried out.

An example of this is the Dupont Company at Barksdale, Wisconsin, which has been polluting Boyd Creek, a tributary of Lake Superior, since 1914, even though Wisconsin's first antipollution law was passed in 1899. It was not until last year that the Resource Development Board issued an order that this pollution should be cleaned up by October 1970. The order stated that the least desirable alternative was to pipe this waste out into Chequamegon Bay. This is a completely unsatisfactory solution and the Federal Government should demand a better method.

Another example of States logging is that Minnesota has allowed Reserve Mining Company to continue to release taconite tailings into Silver Bay, even though it has been shown that these tailings have gone beyond the limits of the State permit. Mining company spokesmen have reached into the air and stated that it would cost $200 million not to dump these tailings into the lake. The Bureau of Mines estimate is a $7 million investment and an annual cost of $3 million a year. If the $7 million investment were depreciated over a 7-year period, the net added production cost would be $4 million a year, or 40¢ per ton of taconite.

Dravo Corporation, Pittsburgh, Pennsylvania, recently was involved in tailings disposal for a 1 million-ton-a-year plant and costs were approximately 15¢ per ton. The 40¢ a ton figure for Reserve looks high, particularly when you take into account that the cost per ton for a closed water cycle should come down as plant size goes up.

I am including with this statement, and I have given it to the reporter, the financial statements of the Reserve Mining Company parent companies, Armco Steel Corporation, and Republic Steel Corporation.

(The above-mentioned financial statements follow.)

REPUBLIC STEEL CORPORATION AND CONSOLIDATED SUBSIDIARIES

statement of consolidated income

Years ended December 31, 1967 and December 31, 1966

	1967	1966
Sales, less discounts allowed	$1,266,315,782	$1,359,758,378
Dividends, interest, and other income—Note A	12,615,364	14,341,293
TOTAL.	$1,278,931,146	$1,374,099,671
Costs and expenses:		
Manufacturing cost of products sold	$1,022,691,868	$1,092,046,642
Administrative and selling expenses	60,728,774	58,436,001
Provision for depreciation and depletion	73,039,081	68,964,950
Interest and expense on long-term debt	12,347,764	10,986,130
Sundry other deductions	2,044,011	855,594
Federal income taxes (deferred tax credits 1967—$444,420; 1966—$132,113)—Note E.	32,900,000	49,100,000
TOTAL.	$1,203,751,498	$1,280,389,317
CONSOLIDATED NET INCOME.	$ 75,179,648	$ 93,710,354
Net income per share of common stock.	$4.75	$5.93

See notes to consolidated financial statements.

	December 31, 1967	December 31, 1966
Current Assets		
Cash	$ 54,369,092	$ 61,610,587
Marketable securities—at cost and accrued interest (approximate market)	44,453,686	28,862,110
Accounts and notes receivable—trade, less allowances for possible losses ($2,400,000 in each year)	115,309,958	103,074,720
Inventories—Note B	289,398,901	285,942,005
TOTAL CURRENT ASSETS	$ 503,531,637	$ 479,489,422
Investments and Other Assets		
Investments in and receivables from unconsolidated subsidiaries—Note A	$ 16,669,751	$ 14,477,806
Investments in and receivables from associated companies—Note C	46,062,527	48,758,128
Miscellaneous investments and receivables	13,978,643	13,094,386
	$ 76,710,921	$ 76,330,320
Properties		
Steel producing, manufacturing, raw material and transportation facilities—at cost	$1,876,057,267	$1,722,086,152
Less allowances for depreciation, depletion, and amortization	955,778,514	889,325,512
	$ 920,278,753	$ 832,760,640
Deferred		
Prepaid royalties and other deferred charges	22,486,925	22,524,285
	$1,523,008,236	$1,411,104,667

PUBLIC STEEL CORPORATION AND CONSOLIDATED SUBSIDIARIES—DECEMBER 31, 1967 AND DECEMBER 31, 1966

	December 31, 1967	December 31, 1966
urrent Liabilities		
Accounts payable and accrued liabilities	$ 146,901,682	$ 154,210,891
Federal income taxes	6,383,193	22,138,207
Taxes—other than federal income taxes	26,280,876	26,726,588
TOTAL CURRENT LIABILITIES	$ 179,565,751	$ 203,075,686
ong erm Debt—Note D	339,163,775	242,460,841
ther Liabilities and Reserves		
Deferred federal income taxes—Note E	$ 44,981,798	$ 45,426,218
Reserves and other liabilities	6,319,922	8,002,730
	$ 51,301,720	$ 53,428,948
tockholders' Equity		
Capital stock:		
Prior preference—par value $100 per share; authorized 467,698 shares; none issued		
Common—par value $10 per share; authorized 28,000,000 shares; issued 15,855,142 shares (1966—15,821,374 shares) including shares in treasury—Note F	$ 158,551,420	$ 158,213,740
Capital surplus	146,741,626	145,906,583
Incr[illegible] retained and invested in the business—Note D	647,879,223	608,214,148
	$ 953,172,269	$ 912,334,471
Less common stock in treasury—29,990 shares at cost	195,279	195,279
	$ 952,976,990	$ 912,139,192
	$1,523,008,236	$1,411,104,667

REPUBLIC STEEL CORPORATION AND CONSOLIDATED SUBSIDIARIES

Statements of Consolidated Capital Surplus and Income Retained and Invested in the Business

Years ended December 31, 1967 and December 31, 1966

	1967	1966
Capital Surplus		
Balance at beginning of year	$145,906,583	$145,612,159
Amount received upon exercise of stock options in excess of portion (1967—$337,680; 1966—$119,260) credited to common capital stock account	835,043	294,424
Balance at end of year	$146,741,626	$145,906,583
Income Retained and Invested in the Business		
Balance at beginning of year	$608,214,148	$548,056,652
Adjustment of investments in unconsolidated domestic subsidiaries from cost thereof to equity in net assets at January 1, 1967—Note A	4,014,160	—0—
Net income for the year Profit	75,179,648	93,710,354
	$687,407,956	$641,767,006
Cash dividends paid on common stock (1967—$2.50 per share; 1966—$2.125 per share)	39,528,733	33,552,858
Balance at end of year	$647,879,223	$608,214,148

See notes to consolidated financial statements.

UNDIVIDED PROFIT Retained 1967 — $35,650,915

Republic Steel Corporation and Consolidated Subsidiaries

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

December 31, 1967

NOTE A—Principles of Consolidation

The consolidated statements include the accounts of the Corporation and two wholly-owned subsidiaries. Investments in unconsolidated domestic subsidiaries were adjusted at the beginning of 1967 from cost thereof to equity in the net assets of such subsidiaries, and the excess of equity was credited to income retained and invested in the business. The equity in net income of these subsidiaries for the year 1967 ($780,000) was included in consolidated net income. Financial statements for the year 1966 were not restated since the effect of this adjustment was not material.

Investments in unconsolidated foreign subsidiaries are carried at cost. The equity of the Corporation in the undistributed net income of such subsidiaries, since dates of acquiring controlling interests therein, amounted to approximately $20,810,000 at December 31, 1967. Dividends received ($5,250,000) and credited to consolidated income for the year 1967, exceeded net income of such subsidiaries by approximately $2,075,000.

NOTE B—Inventories

Inventories are stated at cost (principally last-in, first-out), not in excess of replacement market. A summary of inventories follows:

	Dec. 31, 1967	Dec. 31, 1966
Ore	$ 37,789,199	$ 42,685,856
Scrap	10,593,110	10,395,562
Fuel	10,514,013	10,068,378
Ferrous metals and alloys	4,393,292	8,469,668
Rolls, molds, and stools	13,080,399	14,537,391
Stores and manufacturing supplies	17,407,371	14,422,865
Miscellaneous materials	4,517,820	4,564,364
Pig iron	14,479,580	14,390,600
Product—semifinished	54,983,840	49,548,525
Product—finished and in process	121,640,277	116,858,796
TOTAL	$289,398,901	$285,942,005

NOTE C—Associated Company

The Corporation's investments include $28,029,107 representing the carrying amount of capital stock of Reserve Mining Company (representing a 50% interest) and of other funds furnished to Reserve by the Corporation. The other 50% capital stock interest is owned by Armco Steel Corporation. Separate financial statements for Reserve are included in reports filed annually with the Securities and Exchange Commission.

At December 31, 1967, Reserve had $93,254,000 Series A and $75,680,000 Series B Bonds outstanding. Until such bonds are paid in full, its shareholders are obligated according to their proportionate interest to take the entire production of Reserve and to pay its costs pursuant to the provisions of certain agreements. To the extent that may be required, the stockholders of Reserve have agreed to furnish Reserve amounts needed to pay fixed sinking fund installments on such bonds and any remaining principal amounts at their respective maturities; also for certain other purposes, funds would be obtained from its stockholders pursuant to subscription agreements.

NOTE D—Long-term Debt

Long-term debt outstanding at December 31, 1967, is shown in the following summary:

Republic Steel Corporation:	
4⅜% Sinking Fund Debentures due 1985 (annual sinking fund payments, excluding prepayments for 1968: 1969 and 1970—$3,000,000; 1971 through 1983—$7,000,000; 1984—$8,000,000)	$113,000,000
4.65% Notes, due May 1, 1989 (payable $6,250,000 annually from 1970 to 1989)	125,000,000
Promissory notes payable to banks (payable as stated below)	100,000,000
Promissory notes payable to customer (payable in monthly installments based upon steel products purchased) interest at 3%	1,163,775
TOTAL	$339,163,775

Notes payable to banks were issued under the terms of a Revolving and Term Loan Credit Agreement and bear interest at the prime commercial rate (currently 6%). Notes issued under the revolving credits mature December 31, 1970, and under the term loan credits in ten semiannual installments commencing June 30, 1971. The Corporation has the option to borrow

notes to
consolidated
financial
statements
(continued)

a maximum of $75,000,000 under a new Revolving and Term Loan Credit Agreement to be effective February 15, 1968. Notes issued under the revolving credits would mature February 29, 1972, and under the term loan credits in four annual installments commencing February 28, 1973.

The loan agreements contain certain restrictions relating to the payment of cash dividends and maintenance of net current assets. Under the most restrictive covenant, income retained and invested in the business at December 31, 1967, was unrestricted to the extent of approximately $223,970,000.

NOTE E—Federal Income Taxes

Federal income taxes currently payable, based upon taxable income after the deduction of percentage depletion, were reduced by credits for investment in depreciable property ($9,882,000) and foreign taxes.

Deferred federal income taxes were attributable to deductions by the Corporation for tax purposes of its share of the depreciation and amortization charges of Reserve Mining Company in excess of amounts recorded on the books of Reserve, and to the excess of depreciation charges of the Corporation for tax purposes over amounts included in the statement of income.

NOTE F—Stock Options

At December 31, 1967, there were 121,452 shares of common stock reserved for exercisable outstanding options under the 1951 Stock Option Plan, now expired, at option prices aggregating $7,181,000. No options under this plan were exercised during 1967. Options were canceled for 18,250 shares at aggregate option prices of $1,074,000.

There were 338,542 shares of common stock reserved at December 31, 1967, for issuance under the 1962 Stock Option Plan for officers and other key employees. The plan provides that options may be granted at not less than the fair market value at the date of grant; that options granted prior to March 15, 1966, shall be exercisable over a period of not more than ten years; and, that options granted thereafter shall be exercisable over a period of not more than five years. Options were outstanding at December 31, 1967, for 333,667 shares (176,827 exercisable) at aggregate option prices of $12,077,000 ($6,221,000 exercisable). During 1967 options were granted for 5,000 shares and were exercised for 33,768 shares at aggregate option prices of $225,000 and $1,173,000 respectively. Options were canceled for 6,825 shares at aggregate option prices of $241,000.

NOTE G—Pensions

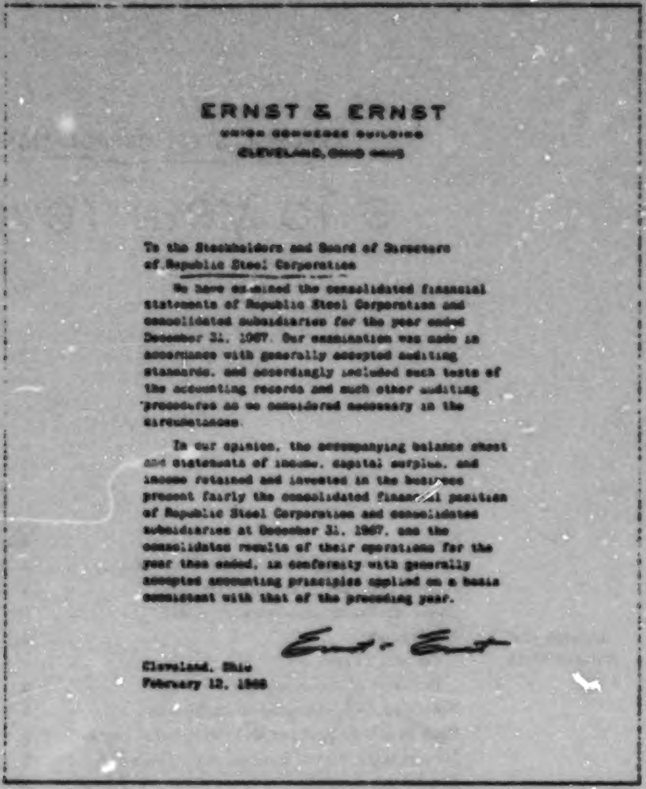
The Corporation and consolidated subsidiaries have contributory and non-contributory pension plans which cover substantially all employees. Pension costs, which are funded, were $23,744,000 for the year 1967 including amortization of prior service costs. Pension fund assets exceeded the actuarially computed value of vested benefits under the plans at December 31, 1967.

Note H—Other Matters

In connection with certain bank loans of an unconsolidated domestic subsidiary, the Corporation has agreed to purchase the notes evidencing such loans up to a maximum of $8,600,000 principal amount if such notes are not paid at maturity. Notes in the principal amount of $5,000,000 were outstanding at December 31, 1967.

In the event certain companies supplying raw materials to the Corporation, and in which it holds stock investments, are unable to make the necessary payments on their long-term indebtedness (in connection with financing the construction of facilities) the Corporation has agreed to pay its proportionate share ($19,868,000 at December 31, 1967) thereof up to a maximum amount of $21,028,000. The Corporation is also committed to make additional investments in certain companies in the maximum amount of $924,000.

accountants' report



ERNST & ERNST
UNION COMMERCE BUILDING
CLEVELAND, OHIO [illegible]

To the Stockholders and Board of Directors
of Republic Steel Corporation

We have examined the consolidated financial statements of Republic Steel Corporation and consolidated subsidiaries for the year ended December 31, 1967. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statements of income, capital surplus, and income retained and invested in the business present fairly the consolidated financial position of Republic Steel Corporation and consolidated subsidiaries at December 31, 1967, and the consolidated results of their operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Ernst & Ernst

Cleveland, Ohio
February 12, 1968

Principal Subsidiary and Associated Companies

December 31, 1967

Consolidated In Financial Statements

Union Drawn Steel Company, Ltd.
River Terminal Railway Company

Carried as Investments in Financial Statements

	% of Ownership
Beatrice Pocahontas Company, Buchanan County, Va.	50%
Carol Pellet Company, Labrador, Canada	7.69%
Cuyahoga Corporation, Cleveland, Ohio	100%
Donner-Hanna Coke Corporation, Buffalo, N. Y.	50%
Iron Ore Company of Canada, Labrador and Quebec, Canada	5.13%
K. & S. Metal Supply, Inc., New York, N. Y.	100%
The Negaunee Mine Company, Negaunee, Mich.	10.5%
Pioneer Pellet Plant, Negaunee, Mich.	15%
Presque Isle Corporation, Alpena, Mich.	41%
Republic Supply Company, Oklahoma City, Okla.	100%
Reserve Mining Company, Silver Bay and Babbitt, Minn.	50%
The Prospect Corporation, Monrovia, Liberia (Liberia Mining Company, Ltd. 59.18%) (Tankore Corporation 50%)	100%
Vance Iron & Steel Company, Chattanooga, Tenn.	100%
Witherbee Sherman Corporation, Port Henry, N.Y.	100%

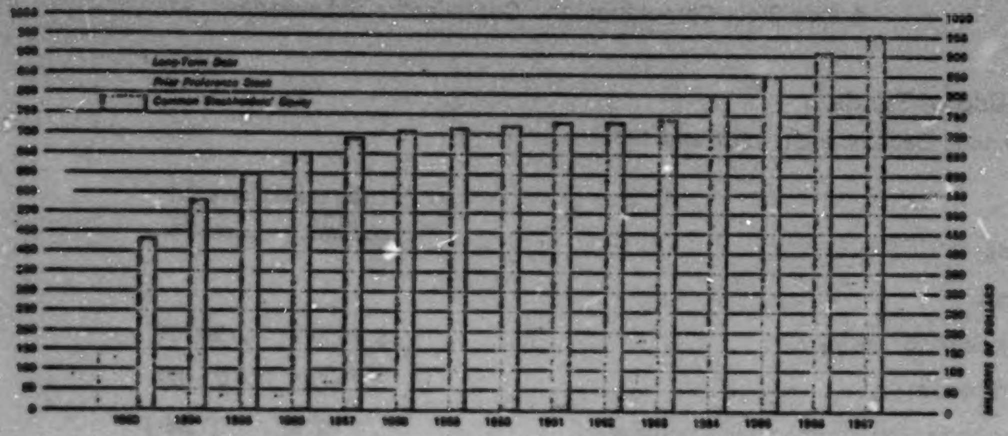
REPUBLIC STEEL CORPORATION AND CONSOLIDATED SUBSIDIARIES

a 15 year review in figures

Dollars and tons in thousands

		1967	1966	1965	1964	1963
Income and Related Data	Sales	$1,266,316	1,359,758	1,374,541	1,272,742	1,114,192
	Depreciation, depletion, and amortization	$ 73,039	68,965	63,391	60,134	58,93
	Interest and expense on long-term debt	$ 12,348	10,986	10,141	9,422	8,915
	Taxes (excluding social security taxes)	$ 59,267	76,169	60,474	57,078	63,20
	Net Income	$ 75,180	93,710	77,302	72,277	55,501
	Per cent to sales	5.9%	6.9	5.6	5.7	5.0
	Per share of common stock	$ 4.75	5.93	4.90	4.58	3.52
	Total cash dividends paid to stockholders	$ 39,529	33,553	31,553	31,512	31,498
	Cash dividends paid per share of common stock	$ 2.50	2.125	2.00	2.00	2.00
	Income retained and invested in the business	$ 39,665	60,157	45,749	40,765	24,003
	Capital expenditures	$ 161,823	140,412	134,719	118,463	56,405
nancial Position *at December 31*	Working capital	$ 323,966	276,414	294,353	276,919	260,05
	Ratio current assets to current liabilities	2.8 to 1	2.4 to 1	2.8 to 1	2.5 to 1	2.7 to 1
	Properties, plants and equipment—[illegible]	$ 920,279	832,761	768,714	701,744	646,439
	Long-term debt	$ 339,164	242,461	251,720	210,348	180,816
	Total stockholders' equity	$ 952,977	912,139	851,568	805,296	764,00
	Stockholders' equity per share of common stock	$ 60.22	57.76	53.97	51.08	48.51
	Number of stockholders	100,403	104,478	104,953	105,856	104,826
Operating Data	Raw steel production—tons	9,303	10,010	9,894	10,210	8,543
	Production index (1957-1959 = 100)	124.5	133.9	132.4	136.2	114.3
	Steel shipments—tons	6,406	6,877	7,143	6,711	5,899
	Pig iron production—tons	7,017	7,672	7,060	7,161	5,652
	Pig iron shipments—tons	449	584	594	595	442
ployment Data	Average number of employees	50,376	53,412	55,888	53,488	49,069
	Average hours per week	36.2	37.2	36.5	37.7	36.8
	Employment costs	$ 478,350	498,001	489,576	471,989	421,105
	Per hour	$ 5.03	4.81	4.60	4.48	4.47

CAPITAL STRUCTURE RELATIONSHIP



1961	1960	1959	1958	1957	1956	1955	1954	1953
965,903	1,053,873	1,076,832	910,303	1,227,258	1,244,214	1,188,560	846,311	1,137,124
41,0[illegible]2	36,371	34,666	33,074	40,788	43,059	45,472	41,613	41,046
9,206	5,786	3,804	2,713	1,448	1,494	2,028	4,533	5,090
8,027	69,895	69,407	77,311	115,588	110,438	98,467	62,783	114,436
6,954	52,846	53,890	61,922	85,014	90,407	86,271	52,875	56,744
5.9	5.0	5.0	6.8	6.9	7.3	7.3	6.2	5.0
3.62	3.36	3.43	3.96	5.45	5.83	5.59	3.55	4.63
47,197	47,113	47,018	46,858	46,704	40,631	38,404	29,787	28,345
3.00	3.00	3.00	3.00	3.00	2.625	2.50	2.25	2.25
9,757	5,733	6,872	15,064	38,310	49,776	47,867	23,088	28,399
89,117	119,607	46,088	47,714	149,625	106,807	35,925	20,003	21,791
249,029	282,432	235,174	245,896	212,214	244,937	256,130	226,397	192,311
2.7 to 1	3.0 to 1	2.4 to 1	3.0 to 1	2.6 to 1	2.8 to 1	3.6 to 1	3.3 to 1	2.9 to 1
656,523	610,714	528,876	517,338	502,099	391,548	334,689	352,380	304,098
219,783	214,728	94,896	98,139	75,984	40,755	44,030	91,468	150,819
739,202	728,259	722,000	713,316	697,207	657,494	606,097	537,850	470,060
46.95	46.36	46.01	45.62	44.71	42.39	39.26	36.71	37.11
93,640	90,915	88,644	91,969	94,891	90,421	83,063	69,464	65,914
7,251	7,700	7,508	6,430	8,485	9,349	9,680	6,973	9,630
97.0	102.8	100.4	86.0	113.5	124.8	129.5	93.3	128.9
4,905	5,304	5,446	4,464	6,211	6,783	6,989	5,012	7,136
93	5,528	5,075	4,623	6,711	6,575	6,599	4,572	6,599
29	385	438	457	720	829	736	532	667
48,675	55,927	64,173	51,622	65,110	68,918	66,083	57,753	69,463
35.5	34.0	39.3	33.5	35.8	35.6	37.9	34.8	38.7
381,746	410,262	404,220	350,933	433,315	418,850	395,603	300,580	380,701
4.23	4.12	3.88	3.89	3.57	3.27	3.03	2.86	2.72

Source and Use of Funds

For the years ended December 31, 1967 and 1966

	(Dollars in thousands) 1967	 1966
Source of Funds		
Operations		
Net income for the year	$ 70,647	$ 86,737
Depreciation	79,160	71,027
Deferred Federal income taxes (decrease)	(216)	(1,264)
Total	149,591	156,500
Increase in long-term debt	60,000	—
Bank loans	—	8,000
From other sources—net	6,613	68
Total	216,204	164,568
Use of Funds		
Capital expenditures	154,110	195,103
Cash dividends	44,475	44,411
Increase in investments (Retained Profits)	31,373	5,331
Decrease in accounts payable and accruals (increase)	25,698	(19,215)
Increase in accounts and notes receivable	8,849	11,130
Increase in inventories	2,596	5,868
Payments on long-term debt (Note 1)	—	21,749
Total	267,101	264,377
Decrease in Cash and Marketable Securities for Year	50,897	99,309
Cash and Marketable Securities		
Beginning of year	136,550	236,359
End of year	$ 85,653	$136,550

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(1) See notes to financial statements—Note 2, page 23.

Investments (Note 1)

December 31, 1967 (Dollars in thousands)

	Percentage of Ownership	Amount
Foreign Subsidiaries Not Consolidated (Note 2)	60-100	$ 23,426
Bellefonte Insurance Company	100	1,142
Truss Pipe Company	50	530
Associated Companies (Note 3)		
Reserve Mining Company	50	28,029
Iron Ore Company of Canada	5.13	5,709
Oregon Metallurgical Corporation	29.27	4,200
Carol Pellet Company	7.69	1,717
A. O. Smith Corporation of Texas	50	500
Iron Ore Transport Company, Limited	18	297
Oglebay Norton Company	3.94	233
One Domestic and Seven Foreign Companies	20-50	2,440
Total Associated Companies		43,125
Notes and Accounts Receivable— Not Current, and Miscellaneous Securities, etc.		32,517
Total		$100,740

(1) The investments in Bellefonte Insurance Company (wholly-owned) and Truss Pipe Company (joint venture partnership) are stated at equity; all other investments are stated at cost.

(2) Armco's equity in the net assets of foreign subsidiaries not consolidated amounted to $55,211,000 at October 31, 1967, based upon translating their audited financial statements into United States dollars at appropriate rates of exchange. Dividends received from such foreign subsidiaries (included in revenues for the year) were $704,000 less than Armco's equity in their combined net income.

(3) Armco's equity in the net assets of associated companies amounted to $53,036,000 at December 31, 1967, based upon unaudited financial statements furnished by the companies. Armco's investment in Reserve Mining Company is its equity in that company's net assets. Separate financial statements for Reserve are included in reports filed annually with the Securities and Exchange Commission.

perties and Accumulated Depreciation

the year ended December 31, 1967 (Dollars in thousands)

	Total	Buildings	Machinery and Equipment	Other	Construction in Progress
perty, Plant, & Equipment—At cost					
Balance, January 1, 1967 (Note 1)	$1,371,212	$159,212	$ 978,325	$ 96,935	$136,740
Additions (deductions)...............	154,110	12,554	186,540	13,054	(58,038)
Less retirements....................	13,835	1,125	8,967	3,743	—
Balance, December 31, 1967.......	1,511,487	170,641	1,155,898	106,246	78,702
s Accumulated Depreciation (Note 2)...	786,992	83,167	649,501	54,324	—
perty, Plant, & Equipment—Net.....	$ 724,495	$ 87,474	$ 506,397	$ 51,922	$ 78,702

ncludes Olympic Screw & Rivet Corporation (See notes ancial statements—Note 1, page 23).
epre ion for the year amounted to $79,160,000, as com- l wit ,027,000 for the previous year. Provision for de- ation .. new facilities acquired since January 1, 1955, is uted generally by applying to the net book value of each of assets a rate equal to double the straight-line com- rates except that the sum-of-the-years-digits method of determining depreciation is used for the major portion of machinery and equipment acquired after January 1, 1966. Provision for depreciation of other facilities is made, for the most part, at straight-line composite rates. Generally, the rates used in computing the provision for depreciation are designed to extinguish the cost of the properties through charges to operations and credits to accumulated depreciation over their estimated productive (guideline) lives.

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countants' Opinion

SKINS & SELLS
IFIED PUBLIC ACCOUNTANTS

co Steel Corporation, its Shareholders and ctors:

e have examined the statement of consoli- d financial position of Armco Steel Corpora- and consolidated subsidiaries as of December 967 and the related statement of consolidated ne and income retained in the business for ear ended, and the supplemental sched- of source and use of funds, investments, and erties and accumulated depreciation as of that and for that year. Our examination was made cordance with generally accepted auditing lards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, such financial statements present fairly the financial position of the companies at December 31, 1967 and the results of their operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year; and the supplemental schedules present fairly the information shown therein.

nnati, Ohio
ary 8, 1968

Haskins & Sells

10 Year Summary

Results for Year (net tons and dollars in thousands)	1967	1966	1965
Revenues			
Sales, less discounts, returns, and allowances	$1,138,138	1,224,605	1,188,545
Dividends, royalties, and interest	25,529	26,219	23,763
Total	1,163,667	1,250,824	1,212,308
Costs and expenses			
Cost of products sold	978,766	1,017,366	960,026
Selling, general and administrative expenses	90,760	88,623	86,366
Interest and expense on long-term debt	10,675	9,489	5,727
Sundry other charges (credits)	(1,194)	(281)	(706)
Federal, state, and foreign income taxes	14,013	48,890	67,387
Total	1,093,020	1,164,087	1,118,800
Net income (Note 1)	$ 70,647	86,737	93,508
Net income per share of common stock (Note 2)	$ 4.74	5.86	6.32
Cash dividends	$ 44,475	44,411	44,411
Cash dividends per share of common stock	$ 3.00	3.00	3.00
Net income retained in the business after cash dividends	$ 26,172	42,326	49,097
Raw steel production (net tons)	7,455	7,816	7,755
Shipments (net tons) (Note 3)	4,874	5,230	5,236
Year-End Data			
Working capital	$ 352,881	366,635	364,790
Property, plant, and equipment			
Balance, less accumulated depreciation	$ 724,495	649,905	526,966
Capital expenditures	$ 154,110	195,103	127,247
Provision for depreciation	$ 79,160	71,027	63,156
Expenditures—lease rights	$ 53,287	—	—
Shareholders' equity			
Common stock	$ 148,933	148,046	148,046
Capital paid-in in excess of par value (Capital surplus)	105,301	106,074	106,074
Income retained in the business (Earned surplus)	633,755	606,285	563,960
Total shareholders' equity	$ 887,989	860,405	818,080
Long-term debt	$ 285,000	205,000	206,879
Per cent earned			
On net sales	6.2%	7.1	7.9
On shareholders' equity (Note 4)	8.1%	10.3	11.8
Common stock			
Book value per share (Note 2)	$ 59.62	58.12	55.26
Shares outstanding (Thousands of full shares) (Note 2)	14,892	14,804	14,804
Number of shareholders	73,709	72,846	67,256
Number of employees (Average for year)	38,439	39,237	38,006

(1) Net income for 1964 includes an extraordinary credit of $5,979,583 ($.40 per share); net income for 1963 includes an extraordinary credit of $4,926,709 ($.33 per share).

(2) Based on the number of shares outstanding at end of individual years.

1964	1963	1962	1961	1960	1959	1958
1,063,521	933,439	918,561	887,970	937,999	1,022,429	867,391
22,564	26,184	20,237	23,064	25,617	21,500	17,032
1,086,085	959,623	938,798	911,034	963,616	1,043,929	884,423
[illegible],081	765,273	771,495	721,959	740,392	806,270	694,387
61,928	78,132	77,164	75,887	78,511	78,236	67,742
6,013	6,322	6,612	6,548	6,479	5,896	5,749
324	(3,271)	1,686	1,323	1,099	346	1,609
43,354	47,303	35,948	47,800	66,676	76,117	57,424
1,005,698	893,759	892,905	853,517	893,157	966,865	826,911
80,387	65,864	45,893	57,517	70,459	77,064	57,512
5.43	4.45	3.10	3.89	4.76	5.21	3.89
44,411	44,411	44,411	44,396	44,387	44,377	44,203
3.00	3.00	3.00	3.00	3.00	3.00	3.00
35,976	21,453	1,482	13,121	26,072	32,687	13,309
6,838	5,735	5,005	5,359	4,964	5,129	4,506
4,774	4,163	3,991	3,830	3,994	4,104	3,641
405,698	384,000	364,242	404,021	434,241	337,335	340,971
4[illegible],511	468,238	464,354	433,392	396,431	376,758	377,441
59,100	67,996	90,504	76,034	51,329	37,118	61,088
62,531	61,367	57,383	43,916	40,183	33,335	34,457
—	—	—	—	—	—	—
148,046	148,046	148,047	148,036	147,970	147,955	147,835
106,074	106,074	106,074	106,029	105,826	105,774	105,509
514,863	478,887	457,434	455,952	442,831	416,759	384,072
768,983	733,007	711,555	710,017	696,627	670,488	637,416
130,152	137,980	144,735	151,480	158,850	174,589	107,056
7.6	7.1	5.0	6.5	7.5	7.5	6.6
10.7	9.1	6.5	8.2	10.3	11.8	9.2
51.94	49.51	48.06	47.9[illegible]	47.08	45.32	43.12
14,804	14,804	14,804	14,803	14,796	14,794	14,782
67,626	68,116	68,661	68,232	70,554	70,920	72,305
[illegible]3	34,508	34,399	35,031	39,820	40,307	37,192

(3) Net tons include products manufactured from steel purchased from other suppliers (years 1964 and prior).
(4) Based on average of beginning and end-of-year balances.

Martin Hanson

In the last 5 years, 1963 - 1967, these two companies have averaged more than $75 million a year in retained net income.

These companies can easily afford antipollution measures not only because of their large retained earnings but also because they have had 12 years of operation with substantial savings without waste treatment. The plant has operated for a period long enough to enjoy substantial depreciation and now enjoy assurance of no added tax cost since passage of the Minnesota Taconite Amendment.

We urge the Corps of Engineers not to renew the permit to allow releasing these tailings into the navigable waters of Lake Superior.

Lake Superior is the best of our Great Lakes, Let's keep it that way.

I would like to further comment that I thought it was in very poor taste that Commissioner Klein would refer to Charles Stoddard and refer to the Stoddard Report. I have considered some of his statements a personal attack on a very fine person and one of the best of the people we have in the natural resource field in our country today.

(Applause.)

MR. FRANGOS: Mr. Chairman, I have a resolution received from the Wisconsin Federation of Women's Clubs that I would like to read for the record.

Wisconsin Federation of Women's Clubs

A resolution of the Wisconsin Tenth District Convention, General Federation of Women's Clubs.

WHEREAS: The health and welfare of future generations of this Nation will depend directly upon the availability of an extensive supply of clean, fresh water; and

WHEREAS: The people of this Nation have the right to the enjoyment of clean and unpolluted lakes, rivers, and streams, both for aesthetic and recreational enjoyment; and

WHEREAS: There are many practices in our society at present, whether committed in ignorance of knowingly, by private individuals or corporate bodies, which threaten our waterways with escalating pollution;

THEREFORE BE IT RESOLVED: That the Wisconsin Tenth District Convention of the General Federation of Women's Clubs strongly opposes any and all activites which tend to degrade the quality of the waters of this Nation, whether by processes which increase sedimentation or poison and pollute the waters, undermining their natural life-sustaining character; and

BE IT FURTHER RESOLVED: That this Convention calls upon the Federal, State, and local governments, and upon private citizens and corporate bodies, to exercise every legitimate means within their power to end the degradation of our waters and to secure for this Nation's people and their descendents as pure a quality of water as nature endowed us with.

Wisconsin Wildlife Federation

Passed by vote of the Convention April 23, 1969, at Spooner, Wisconsin.

For the Convention:

Signed, Catheryn Johnson, Washburn, Wisconsin, and Isabel Lamal, Ashland, Wisconsin.

Mr. Chairman, I have a communication received from the Wisconsin Wildlife Federation. It was prepared by Richard A. Hemp, presented by Harry S. Pomeroy, Vice-president, Mr. Pomeroy could not be with us.

The Wisconsin Wildlife Federation is a statewide organization of conservation clubs and individuals affiliated with the National Wildlife Federation. The Federation represents 63 local clubs and approximately 12,000 members.

The Wisconsin Wildlife Federation can offer no technical solution to the problems of Lake Superior water quality, except to suggest that the most direct, obvious, and economical way to maintain high water quality is to prohibit the discharge of any element, waste, by-product, or substance into the water which has the property to downgrade its quality.

Persuasive arguments can often be heard that a single given operation or development cannot by itself harm the environment in any appreciable or noticeable degree. This may very well be so.

Wisconsin Wildlife Federation

However, the aggregate of these so-called semi-harmless developments can in their total sum build up, in relationship to their number, a massive pollution problem.

We have seen the other four of the Great Lakes "go down the drain" because too little attention was given the problems as they were building up and forthright action is now hard to come by because of the irreversible nature of past and present developments.

In Lake Superior we have the largest relatively unspoiled body of water remaining in America. The opportunity to prevent its despoliation is here and now while its water quality, as compared to the other Great Lakes, is still relatively high.

Certainly if we drift into a policy of permitting this and then permitting that because this operation or that development has no apparent effect on the ecology of the lake, we are passing an eventual death sentence on this magnificent body of water, much in the same manner in which the other Great Lakes are doomed to die, unless through long, costly, and ponderous processes we can reserve this judgment.

The Wisconsin Wildlife Federation is categorically opposed to pollution in any form. Let's save Lake Superior from the thoughtless, reckless exploitation which has marked our natural resource use up to now."

B. C. Prentice

I have had a request from Dr. B. C. Prentice to make a statement to this Conference.

Is Dr. Prentice here?

A VOICE: He couldn't make it. I will give it to you for the record. He cannot be here.

MR. FRANGOS: All right.

(The statement of Dr. Culver Prentice was read and follows.)

W. E. BARNHOLTZ, M. D.
J. E. KREMER, M. D.
J. W. PRENTICE, M. D.
E. C. PRENTICE, M. D.
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SMILES-PRENTICE MEDICAL GROUP
206 SIXTH AVENUE WEST
ASHLAND, WISCONSIN
54806

May 13, 1969

Chairman
F W P C A Enforcement Hearing
Duluth, Minnesota

My name is Dr. Culver Prentice of Ashland, Wisconsin. I speak as a concerned private citizen and as the Chairman of the "Citizens Committee for an Apostle Island National Lake Shore." I have lived and worked my entire adult life in the ~~e~~environs of Lake Superior. My home is on its shore. Bays, beaches and tributaries have shaped my life. I have plied its waters by sail from Whitefish Bay to the Apostle Islands. I know Lake Superior well and love it deeply.

In the course of this hearing there will be statement and counter-statement relative to what does or does not constitute pollution. There will be attempts to decide which bits of violence done to Lake Superior constitute violations of law, and even whether or not clear violations can or should be brought to account.

All this seems beside the point. The real point is that in Lake Superior we have the last clean and the most magnificent fresh water body in the world, and that its freshness and magnificence is of the most fragile sort.

It has its own peculiar ecology brought into balance over the past eons. A most delicate balance of living organisms, geologic development and climatologic influences. And make no mistake about it, despite its seemingly limitless capacity for dilution this delicate balance will be hideously influenced by any and all pollution! And once the ecologic balance is tipped by pollution, by whatever name it may be called, the plunge to degradation is accelerated.

And just as its magnificence has struck us as being ageless, so too will Lake Superior's pollution be ageless. For even if all forms of pollution were totally stopped, it would take this vast lake 500 years to purge itself!

With these thoughts in mind it is self evident that anything that in anyway disturbs Lake Superior's ecologic balance, be it thermal pollution, municipal sewage, industrial discharges or mill tailings must be prohibited as illegal. And whether or not considered by the law to be illegal such outrages against our environment are opposed to all codes of moral decency.

W. E. BARDHOLTZ, M. D.
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May 13, 1969

Chairman
F W P C A Enforcement Hearing

Page -2-

I would urge the F W P C A to take a strong stand against all forms of alteration of Lake Superior's ecology. I would urge the administration to bring the force of law to bear where there are present violations. I would encourage them to assume a forward looking stance in formulating policies that do not favor municipalities, industries and individuals, but that favor the environment in which we all must function!

Thank you for the opportunity for presenting my views.

B. C. Prentice, M.D. - Chairman
Citizens Committee for Apostle Islands
National Lake Shore

BCP:mla

Don Covill Skinner

MR. FRANGOS: We have had a request from the Reverend Dr. Don Covill Skinner of Northland College to make a statement.

Is Dr. Skinner here?

STATEMENT OF DON COVILL SKINNER,
NORTHLAND COLLEGE, ASHLAND, WISCONSIN

DR. SKINNER: Gentlemen:

My name is Don Skinner. I am a resident of Ashland, Wisconsin, and serve on the faculty of Northland College. Along with these verbal remarks, I am submitting for the record a report of a study conducted by myself and Mr. Henry Lockwood, a Northland College Senior majoring in biology.

(The report follows.)

WRITTEN TESTIMONY SUBMITTED TO THE FEDERAL WATER POLLUTION CONTROL ADMINISTRATION ENFORCEMENT CONFERENCE, LAKE SUPERIOR BASIN, AT DULUTH, MINNESOTA, MAY 13-14, 1969.

Statement submitted by: Dr. Don Covill Skinner, Ashland, Wisconsin
Mr. Henry Lockwood, Northland College.

A. INTRODUCTION

During the late part of April and early May, we conducted experiments to test the effect on marine life of the effluent of the E. I. Du Pont De Nemours Co., Inc. plant at Barksdale, Wisconsin. This effluent enters Boyd Creek as the creek passes through the Du Pont property, and shortly thereafter drains into Lake Superior in Chequamegon Bay.

Our study of this material was motivated by a number of factors, the first being that the general dissatisfaction with the effluent relates to its red color, making it an esthetic nuisance; but we have heard little concerning its impact on the ecology of the stream and the lake. Representatives of the Du Pont plant, in our conversations with them, indicate this is their primary concern. They point to studies indicating that the material, in modest quantities, is not noticeably harmful to warm-blooded animals, and that there have been no reported instances of fish-kills.

We were secondly motivated to conduct this study because we became aware that the state of Wisconsin was dealing with the problem, but only recently, when the problem has existed for fifty-five years, since Du Pont first began to release this effluent in 1914. We had heard rumors as to the toxic quality of the material, and determined to investigate for ourselves.

It should also be stated that we are convinced of Du Pont's good will in their claims that they are working hard to solve the problem. The difficult nature of the problem is witnessed in the fact that all attempts to solve it thus far have proved either ineffectual or economically prohibitive.

On the basis of our study, however, we cannot agree with the view that this is primarily an esthetic problem, and we are very concerned over the quality of the chemical materials in question.

B. THE "RED WATER" PROBLEM

Briefly, the "red water" phenomenon is caused by the runoff of cooling and wash waters at the end of the production of the organic compound 2,4,6-Trinitrotoluene, commonly called TNT, an explosive substance. In the effluent are significant quantities of Nitrotoluene Sulfonic Acid, (NTS), which material has a high coloring capability, and even in small quantities colors the water a bright red. This material is run off as effluent because of certain undesirable components of the TNT production, which are outlined in the appendices at the conclusion of this report.

In the course of our study, we have learned the following about this material: that Nitrotoluene Sulfonic Acid is a highly toxic substance to any organic life, as are all members of the nitro group of organic compounds; that it is a stable compound not easily broken down, and has a low degree of biological degradability; that it does not evaporate out of solution readily, but tends to stay behind in increasing concentration as water evaporates; that it can be broken down by organisms if it is not initiated in lethal dosage, and in vertibrates is reduced to Nitrobenzoic Acid which is capable of being excreted through the kidneys; that this process demands an increased oxygen consumption on the organisms part to facilitate the oxydization process; and that organisms may be greatly weakened physically until the alien material is purged.

An additional danger on which we do not yet have information is the possibility of NTS, under certain conditions, being reduced to Nitrobenzene, a potent organic solvent which will dissolve any living tissue. This material is highly toxic, may be absorbed through the skin or inhaled as vapor, and can only partially be discharged. It turns the blood a chocolate brown and disrupts the functioning of hemoglobin and metahemoglobin.

With this information in hand, we conducted two sets of experiments.

C. FIELD EXPERIMENTS

Using a planktonic drag net, we took samples from Boyd Creek with the following results:

1. A drag of the creek above the Du Pont effluence point yielded a number of life forms normal to creek life.
2. A drag below the Du Pont effluence point yielded no living organisms, but several dead ones in the sediment.
3. A drag at the delta, just prior to the creek's entry into Chequamegon Bay yielded only two small worms of unidentified species.

While in the field, we collected large samples of the stream water both above and below the effluence point, samples of which stand before you, the white water from above, the red water from below. These served as the basis for our laboratory experiments.

D. LABORATORY EXPERIMENTS

Two sets of lab experiments were conducted, the first using microscopic life forms, the second five species of fish common to Lake Superior.

The results of the experiments with microscopic life are not yet completed. We can state, however, that the introduction of the red water into cultures of these organisms results in a significant reduction of life, and in some cases total annihilation. The implications of this fact for the ecology of Chequamegon Bay are extremely profound. These animals assist in the processing of organic materials in the water, somewhat like a waste disposal system, and in turn serve as food for higher life forms. Their destruction can therefore result in both decay of the water quality and loss of the base of the marine food supply.

The fish experiments proved to be more decisive, and are herein outlined. Three experiments were conducted, using the common bate minnow known as shiners, rock catfish, stickleback, suckers and Brook Trout. It should be noted that these species represent a considerable variation in fish life, from highly specialized and sensitive species on the one end to organisms capable of surviving in rather low-quality conditions on the other. We first determined that these species would survive in Boyd Creek water prior to the initiation of the NTS material, and found they thrived. A control tank was maintained throughout the experiments, and at the end these fish were released in a healthy condition into Lake Superior.

In the first experiment, fish were subjected directly to the red stream water as taken from Boyd Creek, with temperature and oxygen control. Fish so treated followed a uniform pattern. Within a few seconds they demonstrated violent swimming behavior, and often made successive leaps out of the water. Within a few seconds after that, they entered a state of extreme intoxification, resembling a siezure, or the spasmodic muscular contractions of a fish which has been stuck on the head with a blunt instrument. Within one minute they had lost equilibrium, and floated on their backs at the surface or on the bottom, and death ensued within several minutes.

It should be noted that in recent trials with a more concentrated solution, as the stream has declined after the spring runoff, fish subjected to the stream water die within a matter of 15 or so seconds.

These experiments were continued in increasingly less concentrated solutions, by the addition of fresh water--as would happen in the lake as the stream water is distributed through the water system--until it was determined that death would not result. It was found in this way that if the stream water were diluted in a ratio of one part to eight ~~ten~~ parts fresh water, fish die within twenty-four hours; but at a ratio of one part stream water to ten parts fresh water, the fish continue to survive.

In the second experiment, fish were placed in tanks containing varying concentrations of solution, ranging from one-to-ten up to one-to-fifty stream water to fresh. Over a ten-day period, all the fish survived with the exception of a few which died almost immediately, apparently because of desease or similar liability. None of the other fish showed significant change, except those in the most concentrated solution. These demonstrated loss of equilibrium, and could not maintain a position midway in the tank, i.e. they either rested on the bottom of floated to the top instantly with the cessation of swimming movements, suggesting a considerable disability. Only one change was noted: the fish showed signs of revival on the eighth day, an explanation for which is provided below.

In the third experiment a group of fish were placed in clear water, and a measured quantity of stream water was added daily for ten days. The dosage was such that on the eighth day the solution should have reached the lethal level. As of the tenth day, however, all the fish remained alive. We postulated that one of two possibilities existed: (a) that the fish had developed a tolerance for the material, a fact unlikely according to the literature, given the toxicity characteristics of NTS; or, (b) that the material was being broken down within the tank environment so that by the tenth day the lethal level had not in fact been achieved. We tested these hypotheses by placing fresh fish from the control tank directly into the experimental tank on the tenth day. Their behavior did not change, and since they had no opportunity to develop a tolerance for the material, it is apparent the lethal level had not been achieved.

Examination of the tank contents revealed little bacterial growth, although some algal growth was noted. It seems more likely, however, that the fish themselves were internalizing the material, processing it, and excreting it in broken-down form, although tests for this are extremely difficult and we have not been able to pursue them. If this hypothesis is correct, however, it would also explain the eighth-day recovery of the fish in above-mentioned one-to-ten solution.

E. CONCLUSIONS

From these studies we have drawn the following conclusions, which have obvious implications, and suggest several serious potential problems:

1. The Du Pont effluent is highly hazardous to marine life, and is definitely not merely an esthetic nuisance. We feel confident to predict that no fish will survive in Boyd Creek or in Chequamegon Bay before sufficient dilution has occurred to render the material tolerable in concentration. That there has been no significant fish-kill is not entirely true. Dr. Newton Bobb, Emeritus Professor of Biology at Northland College, informs us that in 1914, when Du Pont first introduced NTS to Boyd Creek, a once fine trout stream was destroyed, a whole strain of trout killed, and people came from all around during the migration season to pick the dying trout out of the water. The implication is that cleaned up, and given a chance to purge itself, Boyd Creek could again become a trout stream, which suggests what has been done to a recreational and natural resource.

2. While our experiments indicate that some organisms, and perhaps fish, can process NTS over an extended time period, it is also evident that during that period fish suffer a physical debilitation, making them more readily subject to the hazards of the environment, such as predators or desease. We have no information of how this condition might affect reproductive capacity. And perhaps most serious, we have no clues to date as to what the end products of this biological processing might be, or their impact on the chemical composition of Lake Superior waters.

F. RECOMMENDATIONS

Based on these experiments and our conclusions, we wish to enter the following recommendations to this conference:

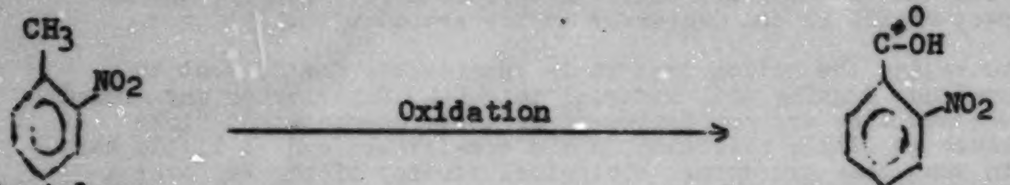
1. Because of the grave impact of NTS on Boyd Creek waters, and its potentially grave impact on Lake Superior, it is our opinion that the toxicity factor has been outweighed by esthetic considerations, and we therefore find unacceptable any proposed solution to the colored water which is based on diluting the material and piping it out to the bottom of Chequamegon Bay. This might solve the esthetic problem by hiding it at the bottom of the bay, but it also obscures from view the biological impact. Given the ecological system of a lake such as Superior, where the shallows areas such as Chequamegon Bay form the base for the entire ecosystem's food supply, the impact of NTS is too dangerous to toy around with.

2. We reject the notion that it is permissible for Du Pont to continue dumping this material into Lake Superior on any ground whatever. We are not impressed by the arguement that since there is little pollution in the area, there can be little harm in what they are doing. Biological studies of the Bay over a period of years since the turn of the century indicate a serious and continuing degradation of the area and a continuous decline of its life-sustaining properties. Adding any pollutant to these waters, especially a material of high toxicity, can only complicate the problem and frustrate a solution.

3. We are appalled, quite frankly, that a Wisconsin state law prohibiting pollution of Lake Superior by industry, passed in 1899, has been ignored in this case until last year. We would like to know how it is that the red water has been present since 1914, but that the first state order to clean it up was not issued until 1968. With this kind of casual attitude on the part of the state regulatory agencies, our environment has little chance of surviving; or, to put it in different terms, if Lake Superior has those kinds of friends, who needs enemies?

APPENDIX A / Characteristics of Nitrotoluene

The properties of Nitrotoluene are similar to those of Nitrobenzene, a potent organic solvent which will dissolve organic materials not otherwise dissolvable. In the body, however, the presence of the CH_3 group renders Nitrotoluene less toxic than Nitrobenzene, because the CH_3 group may be oxidized, resulting in Nitrobenzoic acid, which may be excreted through the kidneys, as illustrated below:



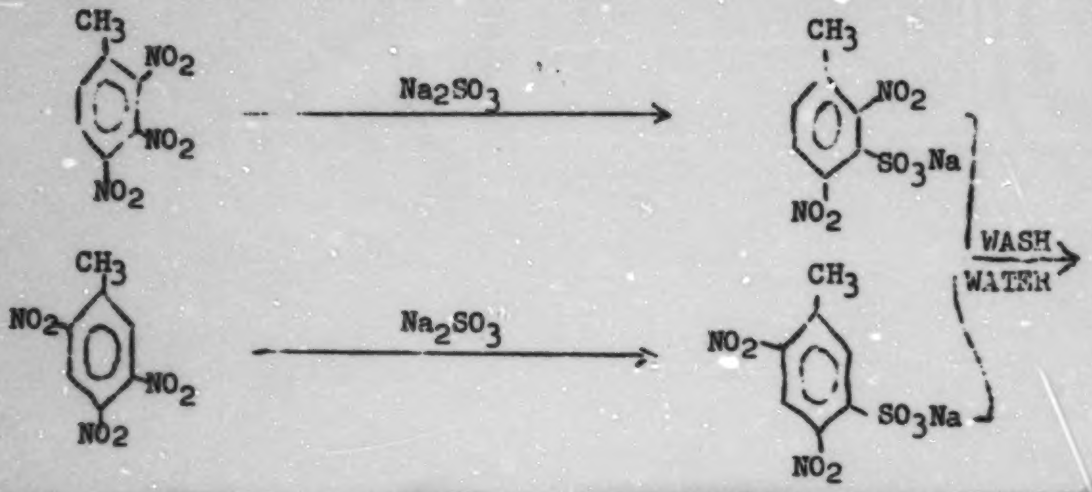
Nitrotoluene
or its isomers

Nitrobenzoic Acid

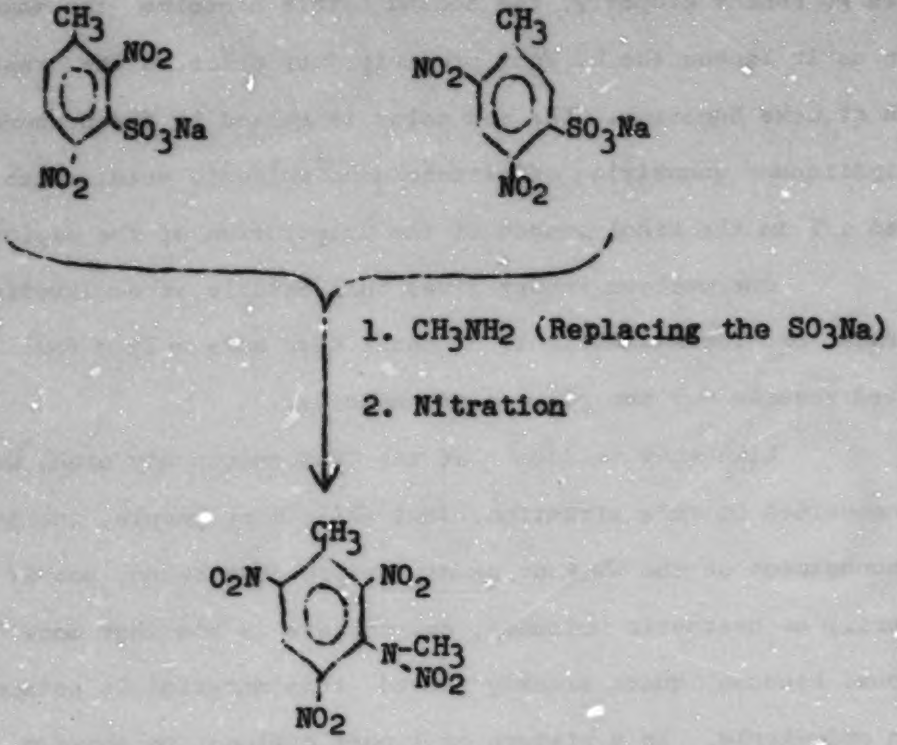
In addition, it is worth noting that traces of Benzoic acid have preservative properties for food. However, the material is considered sufficiently dangerous, even in trace amounts, that the law prohibits its use as a food preservative. These facts suggest something of the hazards which characterize the nitro group of compounds, of which the Nitrotoluene Sulfonic Acid effluent is one.

APPENDIX B / Alternatives to the NTS Effluent Process

Under the present set of circumstances, the production of TNT results in two other products, 2,3,4- and 2,4,5-Trinitrotoluene. Each of these contains a labile nitro group (one which is easily broken off the molecule) which makes them undesired by-products, in that they tend to hydrolize easily and yield Nitric Acid. They are therefore considered contaminants, and are eliminated as follows: crude TNT is warmed in a 5% aqueous solution of Sodium Sultife (Na_2SO_3). The labile NO_2 groups are replaced by the Sodium Sulfinate group (SO_3Na) to yield water soluble derivatives of "reddish sulfite extract," thus the red water color.



The process, however, need not stop here with the washing away of the last yield of compounds as waste as in Boyd Creek. An additional step may be instituted which combines these materials and forms a second explosive material, the schematic formula for which appears below. We have acquainted the Du Pont management with this process (we are unaware of whether or not they have considered it before), but not being industrial chemists we cannot speak to the cost involved or to the marketability of the final product. The idea would at least seem worthy of consideration as an alternative to the pollution of Boyd Creek and Lake Superior.



3-Methyltetryl

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The following deal with the nature and problems of the "red water phenomenon" and difficulties in dealing with it as an effluent.

Stuart Schott, C.C. Ruchhoff & Stephen Megregian, "TNT Wastes," Industrial and Engineering Chemistry, Vol. 35, No. 10, October 1943, pp. 1122-1127.

"Surveys of Liquid Wastes from Munitions Manufacturing," Public Health Reports, Vol. 58, No. 37, September 10, 1943, pp. 1365-1372.

The above were drawn to our attention by the Du Pont management in our personal conversations with them.

Don Covill Skinner

Our study, conducted over the period of the last few months, concerns the impact on marine life of the effluent of the Du Pont plant at Barksdale, Wisconsin.

I have placed before you two bottles of water. The clear water is a sample taken from Boyd Creek at the point it enters Du Pont's property; the second bottle contains the same water as it leaves the Du Pont property just prior to the creek's mouth at Lake Superior. The red color is caused by the presence of significant quantities of nitrotoluene sulfonic acid, which is washed off in the final stages of the preparation of the explosive TNT.

Our written report gives full details of our studies, findings, and recommendations. I shall here make only a few selected remarks for the purpose of emphasis.

Like many residents of the Chequamegon Bay area, we are concerned by this situation. But while many people, including the management of the Du Pont plant, as you just heard, see it primarily as aesthetic nuisance, our concern is somewhat more serious, becuase, quite frankly stated, this material is poison, plain and simple. In a mixture of 1 part effluent to about a thousand parts of stream water - which is what you see before you - a fish will die in a matter of a few seconds to at most a couple of minutes, depending on how high the stream is running when you extract your samples.

Don Covill Skinner

We know this, gentlemen, because we have done it with numerous fish, including shiners, rock catfish, stickleback, suckers, and brook trout. We also know that this material is lethal to those microscopic organisms which form the base of the food chain in a body of water like Lake Superior. We consider this to be an extreme hazard to the lake, because the death of such organisms not only interrupts the normal food cycle of fish upon which we depend for sport and commercial fisheries, but because these organisms are vital in keeping the lake clean. Like a waste disposal system, they process organic material which results from life in the lake, keeping the water clear, and their loss results in a proportional decay of the lake waters.

We see no reason why this situation should be permitted to continue. We further see no reason why the lake should be used as a garbage disposal unit for the processing of the waste products of our industry, urban areas, or private homes. The lake will do some of this for us if we demand it, and if we are willing to live next to and play in an open sewer.

We further find it appalling that this condition has existed since 1914 when Du Pont first began producing TNT at the Barksdale plant; that since 1899 the State has had a statute forbidding the pollution of the lake; but that the first order issued by the State against Du Pont to clean up the situation was not issued until 1968. That certainly does not square well with our Wisconsin pride in being a national leader in matters of pollution abatement and resource conservation.

Don Covill Skinner

If I may depart just momentarily from my written text. The statement that there have been no significant fish killed because of the "red water" problem is not true. A professor at Northland College has studied Chequamegon Bay since 1904, and he recalls in 1914 when the "red water" first entered Boyd's Creek that the trout once having been in the stream turned belly up and died in the creek. And people came from all around to pickup the trout, the trout being up from the stream, as they died. The trout, being an anadnomus fish, return to their spawning grounds. Although the trout did not choose to enter that, they did enter, and that whole stream of trout did go into it.

Because of all the above, we cannot under any circumstances endorse the Du Pont proposal which would solve the problem by piping the material in diluted form out to the bottom of Chequamegon Bay and hide it there. That may solve the aesthetic nuisance, but it fails completely to meet the grave ecological hazards. There are entirely too many unanswered questions concerning the immediate impact and long-term liabilities of flooding the environment with lethal substances.

I would also like to add a brief comment concerning the way we approach this and similar problems. Much has been said lately concerning this conference, asserting we must here ascertain scientific facts; and that this conference will have been a failure if decisions are based on political considerations. I agree, up to a point. That point is defined by my understanding of both politics and science.

Don Covill Skinner

If by science we mean some wonderful medium by which we will solve all human problems and cure all human ills, we are deluding ourselves. This places on science a burden it cannot tolerate. Science is, after all, merely a very specialized way of looking for particular kinds of information. By its nature it is restricted from making value judgments. Science can tell us, for instance, that a particular action will alter Lake Superior in a particular way. This is useful to know. But there are still many actions the effect of which science cannot predict. And even with the information it can give us, science as science cannot tell us whether our behavior is good or bad.

We will have to determine that on the basis of value judgments having to do with what quality of environment we demand for ourselves and posterity, and how much we are willing to pay for it - in money, in human resources, and in friction in our communities as some people demand to take certain liberties with the environment that others are unwilling to give them.

This is why these are political issues, political in the sense that they deal with the processes by which a people govern themselves. For what we are really doing here is taking the pulse of the people to determine just what they will, or will not, put up with.

At heart, political issues are issues of ethical value. And first on our list of values, if our efforts are not to culminate in tragedies like Lake Erie, where I grew up, must be an unwillingness to permit any practice the consequences of which we cannot predict. The fact that we may necessarily have to say at some point that science has not given us a complete answer is not a justification for continued tampering with the environment.

In summary, gentlemen, I contend that where there is a difference of opinion the burden of proof rests with those whose actions have the potential of altering the lake. It is they who must prove their actions harmless, not that those objecting to such practices must prove them harmful. For those doing the objecting know that their goal is the maintenance of the purity of Lake Superior. Those who wish to use it as a dumping ground must either account for their actions fully, or admit their ignorance. And I would remind you that behavior based on ignorance most frequently ends in disaster.

Thank you very much.

(Applause.)

MR. FRANCOS: Mr. Chairman, I would now like to call upon Mr. Charles Stoddard as a citizen of Wisconsin to make a statement to this Conference.

STATEMENT OF CHARLES H. STODDARD, RESOURCE CONSULTANT, WOLF SPRINGS FOREST, MINONG, WISCONSIN

MR. STODDARD: Mr. Chairman, conferees:

Charles H. Stoddard

In the event that anybody here might have missed Mr. Klein's remarks yesterday with respect to a report that was written last winter, I would like to introduce into the record a copy of the Summary Report on Environment Impact of Taconite with Respect to Lake Superior.

MR. DOMINICK: We would be happy to receive that report as an exhibit.

(The above-mentioned report is on file at FWPCA Headquarters, Washington, D. C., and the Great Lakes Regional Office, Chicago, Illinois.)

MR. STODDARD: Over the past 20 years great changes have taken place in the Great Lakes. Probably because economic development has not proceeded as rapidly along Lake Superior as it has along lower Lake Michigan and Lake Erie, we have one Great Lake left which has not yet reached the pollution crisis stage. The issue facing this historic and precedent-setting conference and squarely facing those vested with the authority for enforcing pollution control laws is simply this: Can we clean up existing sources of contamination, and can we build into any new developments prevention devices so as to maintain Lake Superior's purity? An equally basic question is: Can our complex legal and administrative machinery really enforce pollution control laws in the face of heavy economic and political pressures to study, to postpone, to discredit, and, yes, even to use improper influence not to act?

Charles H. Stoddard

I throw down these questions as a challenge directly to the Secretary and Assistant Secretary of the Interior, to the Federal Water Pollution Control Administration, to the pollution control agencies of Michigan, Wisconsin, and Minnesota, and to the U. S. Army Corps of Engineers, St. Paul District Office. Yours is a heavy responsibility to generations unborn, gentlemen.

During the past several months the press and the air have been filled with statements and counter-statements about the Department of Interior report to the Army Corps of Engineers on taconite tailings disposal in Lake Superior. As the coordinator of Interior agencies under authority delegated me by Secretary Udall, mine was the responsibility to implement the Army-Interior agreement of 1967 in the Great Lakes Region.

Under this agreement the Corps requested comments from Interior bureaus on requests for new permits and revalidation of existing permits for dredging, filling, and excavating of the navigable waters of the United States. (It is important to note here that the U. S. Government exercises legal authority in an 1899 Act in these navigable waters at the shoreline - not simply on an imaginary State line at the center of the lake.) On November 1, 1967, the St. Paul office of the Corps issued a notice requesting comments on the revalidation of an existing permit to the Reserve Mining Company of Silver Bay, Minnesota, involving the deposition of 60,000 tons of taconite tailings per day into the lake. Interior bureaus did comment. They suggested a study and only a temporary renewal of the permit originally issued. The study was not a water pollution control study of all of Lake Superior, it was simply on the one single aspect of the Corps of Army Engineers permit to Reserve.

From this point on strict bureaucratic procedures were adhered to - with the one exception that much greater study and detailed fact-finding were planned to find the basic facts of the effects of this highly controversial source of effluent into the lake than is normally required. This procedure is set forth in detail in the submitted attached memorandum from my office to the Chief of the U. S. Army Corps of Engineers, dated January 20, 1969. Subject: Chronology of Lake Superior Taconite Tailings Study.

I would like to introduce into the record a copy of that memorandum.

MR. DOMINICK: We would be happy to have that memorandum as an exhibit.

(The above-mentioned memorandum is on file at FWPCA Headquarters, Washington, D. C., and the Regional Office, Chicago, Illinois.

Charles H. Stoddard

MR. STODDARD: To summarize, five Interior regional agencies - the Bureau of Sport Fisheries and Wildlife, Bureau of Commercial Fisheries, Bureau of Mines, Geological Survey, and Federal Water Pollution Control Administration - cooperated fully under my chairmanship in designing the studies, made their top scientists available for investigations, interpreted their data, submitted reports which were included in toto in the final report. The States of Minnesota and Wisconsin cooperated by having their own pollution agency representatives present at all meetings and by collecting certain portions of the data for which they were particularly well equipped. Each of the three principal participating Federal agencies - Commercial Fisheries, Sports Fisheries and Wildlife and FWPCA - reviewed the draft of the Summary Report - Part I, which I just submitted, prepared by a working committee of those agencies, concurred with the findings that pollution of Lake Superior was resulting from taconite tailings at Silver Bay, and the renewal of the Army Engineers permit should be conditional pending construction of on-land disposal facilities.

Under the circumstances it would not have been possible for me to have influenced the findings in any manner, even if I wanted to do so, which I did not. Hard facts are hard facts, and these men found that taconite tailings are polluting Lake Superior.

The report - Part I (a summary) and Part II (the full research submissions) were tansmitted to Colonel Richard Hesse, District Engineer of the Corps in St. Paul, on December 31, 1968. This is the report here that backs up the summary report. It is fully annotated in every detail.

Charles H. Stoddard

There was no requirement - I repeat no requirement for Washington office "review" of Army-Interior reports. Prior to completion of the report there was a great deal of pressure from citizen groups and the press to release preliminary findings - which we did not. I personally gave Secretary Udall a copy. Copies also were sent to Mr. Jack Bregman, a former staff assistant to former Assistant Secretary Max Edwards, who preceded Mr. Klein, who indicated his office would release the report. Copies were also given immediately to the Reserve Mining Company.

I have subsequently learned that such tremendous pressures were exerted upon Edwards and Bregman that when the report became public that Edwards became concerned enough to make such statements as, "It is full of errors, it contains falsities," etc. But when asked to specify precisely, they could not do so. Neither have any of those who recently made statements to the press been able to do so. However, Water Pollution Control Commissioner Joe Moore, who is an outstanding, tough-minded public servant, on January 28, publicly defended the report but took possible exception only to the conclusion that 60,000 tons of taconite tailings daily were accelerating aging (eutrophication) of the lake. You heard Dr. Bartsch on this yesterday and you know it can happen here.

I would like to introduce Mr. Moore's statement into the record.

MR. DOMINICK: That will be received as an exhibit.

(The above-mentioned statement is on file at FWPCA Headquarters, Washington, D. C. and the Regional Office, Chicago, Illinois.)

Charles H. Stoddard

MR. STODDARD: I would point out to Assistant Secretary Klein and others who publicly questioned the integrity and authenticity of the December 31 Interior Report, that every single finding is documented in this Five-Agency Report, Part II. The main differences between this Interior Report and the single agency FWPCA "An Appraisal of Water Pollution in the Lake Superior Basin" lie in the omission of several significant findings by other Interior agencies. The new FWPCA report did include new findings on taconite tailings in the Duluth water supply, for example. It is an excellent report and corroborates the earlier report's findings. Those which were omitted dealt largely with the findings of other Interior agencies, State matters, enforcement, and disposal recommendations.

In my formal papers I have identified the omissions as:

1) That Federal-State water quality standards are being violated as a result of the discharge of iron, lead, zinc, cadmium, and copper;

3) That turbidity has been found to be widespread and in excess of the Minnesota permit to Reserve;

6) That the 60,000 tons of tailings per day are equal to all of the silt discharged from North Shore streams in a year.

10) that alternate disposal methods are available. Every other taconite plant has on-land closed system tailings disposal.

It is significant, I believe, that numerous speakers preceeding me have quoted liberally from the Interior Report and used its data, even Reserve Mining. It is equally significant that no responsible scientist or layman has very successfully challenged any of the findings of the report labeled by some high public officials as saying completely "false" and "full of errors."

Before the report was finally published it was necessary to obtain the approval of the three Bureaus that I mentioned - Commercial Fisheries, Sport Fisheries and Wildlife, and FWPCA. Each Regional Director submitted letters which directed--I have copies of these available and will introduce them into the record--that these tailings be placed at an on-land disposal site. Specifically, these three key agencies concurred with the following statement:

"The Department of Interior report concluded from the evidence developed in the agencies' studies that:

"1. Pollution is occurring as a result of taconite tailings being deposited in Lake Superior by Reserve Mining Company.

"2. The kind, extent, quanitity, degree, and nature of pollution from this source have been set forth in the main body of the report and in the conclusions.

"3. The environmental effect of such pollution is to increase the turbidity of this once-clear lake, accelerate eutrophication by enrichment of its waters, raise certain chemical constituents to levels beyond established limits, and to decrease available fish foods and fish habitat through deposition of sediment.

"4. Improvement of the lake environment cannot be expected until the taconite tailings waste can be disposed of elsewhere.

"Therefore, the Department of the Interior recommends that the permit of the U. S. Army Corps of Engineers to the Reserve Mining Company be extended conditionally for a period of three years, sufficient to investigate and construct alternate on-land waste disposal facilities, including recycling of used water, in order to comply with Federal-State water quality standards and to restore Lake Superior waters to their original high quality."

Exactly the same process used by all other taconite operations up on the Iron Range. It has not been considered an economic hardship by the companies which are doing this exact same thing, such charges are false and those who make them know full well - good people of Silver Bay.

When this report was received by Secretary Udall he called this conference. He accepted it as official. He told me he wanted a fact-finding conference, that he was satisfied with the facts in this report as the reason for calling it, and he hoped the conference would act on them to keep Lake Superior from becoming another Lake Erie.

I wish that Assistant Secretary Klein, who has said the report has "no official status," were here today. These are serious charges. Mr. Klein apparently has not done his home work - he is new to the Department. If he had, he would have learned that the report was prepared as I have described - strictly according to procedure and with only solid scientific evidence. If it is Mr. Klein's intention to repeal the Udall procedures for Interior review over Army dredging and filling permits - and that is what Mr. Klein is implying - then he puts Secretary Hickel's Administration in full retreat from Udall's conservation record. This is what many feared and it is bad news for the environment.

The test will come when the St. Paul office of the Corps - as Colonel Hesse said in his statement - receives the recommendation of the Hickel-Klein Interior Department. Make no mistake - a recommendation for continued surveillance in place of land disposal will represent a retreat and public demonstration that the law is bent to favor big polluters. Further surveillance and study of an increasingly festering situation is a time-worn bureaucratic evasion from tough decisions in the public interest. Must we wait for the facts of irreversible pollution of Lake Superior before we have the courage to act?

During my period of tenure as Regional Coordinator, one other significant Inter-Bureau study covering the degradation of the St. Louis River and the environmental quality of Jay Cooke State Park was completed at the request of the Under Secretary. I would also like to introduce that into the record.

MR. DOMINICK: That will be received as an exhibit.

(The above-mentioned study is on file at FWPCA Headquarters, Washington, D. C., and the Regional Office, Chicago, Illinois.)

Charles H. Stoddard

MR. STODDARD: Thank you, Mr. Chairman.

It has been reported in the Duluth and Minnespolis press that planning is under way to construct a nuclear plant on the North Shore of Lake Superior approximately 20 miles from Duluth. This site (near the Knife River) is reported to fit the requirements for cooling water amounting to 2 billion gallons per day. The U. S. Atomic Energy Commission is said to be joining with Union Carbide Corporation in this venture. On-the-ground site surveys have been made. This location was chosen because 2 billion gallons of water per day are needed for cooling. This is, incidentally, more water than the Mississippi carried in its recent flood stage at LaCrosse, Wisconsin.

Because of the tremendous and probably damaging impact such a development would have on our outstanding scenic and environmental resources of the North Shore, the likelihood of permanent alteration of the quality of Lake Superior water by thermal pollution and danger from nuclear wastes, people are concerned that apparently the decision to locate this plant has been on the basis of strictly economic and physical suitability without regard to environmental impacts or without regard to local or regional considerations by the residents of the area.

No hearings have been held. Our fear - like all the big projects of recent years - is that the final decision to locate the plant will rest in the hands of a few corporate and agency engineers and planners, and will become irrevocable before alternatives are examined or environmental factors are considered. Are decisions of this kind made in Washington by a few people with political power and then announced to the citizenry? Many of us feel that the decision to build on this site and no other should not become final before these considerations can be properly weighed. I respectfully urge that a series of public hearings be held by an independent and politically responsible body. At such a hearing the following facts should be clearly set forth by the proponents:

(1) Reasons why the Knife River-North Shore site was chosen as against alternative sites which have been considered.

(2) The possibility of using an alternative site within the already polluted Duluth-Superior Harbor which could contain the expected thermal pollution and provide for utilization of waste heat by Twin Ports industries, commercial, and residential buildings.

(3) The extent and input of discharge of nuclear and thermal pollution into the lake.

(4) The effect of the changes of water temperature and what nuclear wastes will do to the lake, and particularly on the research program of the National Water Quality Laboratory - a new facility which could be rendered useless.

Charles H. Stoddard

(5) Finally, a measure of the extent of economic benefit to the area where the project is finally built and what end result will be required for the plant to function.

In conclusion, this conference is in many ways a test of our national moral fiber and our ability to learn from the mistakes on the other Great Lakes. If we follow old procedures of allowing pollution to build up in the wake of economic development, then find the evidence and then try to act, we will pass on a sorry legacy to those who follow us. We will pass on more of the same as Lake Erie and Lake Michigan.

Or we can take a bold approach, turn over a new leaf by cleaning up existing sources of pollution and require that the effluents of any new developments be so handled that no decrease in water quality will take place.

This would call upon the conference to review the now relatively weak water quality standards for the lake - particularly pesticides, thermal and nuclear pollution, siltation, and chemical additives. This conference, when it reconvenes, should establish not only higher standards but a requirement that any new developments producing effluents have a plan for waste recovery or treatment before contamination begins on the lake or its tributaries.

Thank you.

(Applause.)

MR. DOMINICK: Are there any questions?

(No response.)

MR. DOMINICK: Thank you, Mr. Stoddard.

Wisconsin Conservation Congress

MR. FRANGOS: Is there a representative here from the Wisconsin Conservation Congress?

(No response.)

MR. FRANGOS: Mr. Ralph Borst, is he here?

(No response.)

MR. FRANGOS: I take it he is not.

I will read the statement for the Wisconsin Conservation Congress.

The following resolution was unanimously approved by the membership of the North Wisconsin Rod and Gun Club of Ashland, Wisconsin, at is regular meeting held on April 9, 1969:

WHEREAS, the E. W. Davis Works of Reserve Mining Company at Silver Bay, Minnesota, are discharging 60,000 long tons of taconite tailings daily directly into Lake Superior; and

WHEREAS, west to northwest winds move this green colored waste out into Lake Superior and in the direction of the south shore and near the western boundary of the Apostle Islands; and

WHEREAS, the prevailing current in Lake Superior runs counter-clockwise, which increases the amount of pollution into Wisconsin waters; and

WHEREAS, this pollution is known to have harmful effect on plant and marine life;

NOW THEREFORE BE IT RESOLVED that the Wisconsin Conservation Congress, assembled at its annual meeting at

Stevens Point, Wisconsin, April 25-26, 1969, go on record as urging that the Governor of the State of Wisconsin bring pressure to bear upon every State and Federal agency available to an within this power to stop this source of pollution in Lake Superior.

Signed, Richard Miller, President; Dennis Dornfeldt, Secretary; Ralph Borst, Chairman of the Board of Directors.

Is Dr. Robert Sneed of Ashland here?

(No response.)

MR. FRANGOS: Dr. Sneed has asked that the following letter be submitted for the record at the May 13 hearing in Duluth regarding Lake Superior:

(The above mentioned letter follows)

ASHLAND EYE CLINIC
ROBERT J. SNEED, M.D. KENNETH A. MORROW, M.D.
1001 SECOND STREET WEST
ASHLAND, WISCONSIN 54806
PHONE: 682-2305

April 28th, 1969

Mr. Thomas G. Frangos
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Dear Mr. Frangos:

I would like the following letter submitted for the record at the May 13th Pollution Hearing in Duluth regarding Lake Superior:

I am a physician presently living in the town of Ashland, Wisconsin and would like to make a statement regarding pollution in Lake Superior.

I was born and raised in the town of Green Bay, Wisconsin and in this town during the short period of time of my childhood saw Green Bay become grossly polluted for a distance of forty to fifty miles. This was a very distressing thing for me and is the primary reason that I did not return to that area to practice medicine.

I then moved to Duluth, Minnesota where I became aware of the serious pollution problems in that immediate area affecting Lake Superior. The St. Louis River where it flows through Jay Cooke Park has the odor of the effluent from the sulphite wastes of the paper mill immediately upstream. Brown trout caught from that river tasted so strongly of sulphite that they were unpalatable. Walleyes caught in the river down near Fond du Lac also were unable to be eaten because of the pollution. When looking from the hill out over the lake it was very evident that the water from the St. Louis Bay flowing into Lake Superior was badly polluted and caused a very cloudy area to extend out into the clear waters of the lake.

I then moved to the town of Ashland, Wisconsin where the pollution problems were not as severe but were those of municipal sewage as well as the Dupont Chemical Plant at Barksdale, Wisconsin.

This is a fine body of water which has great economic and esthetic value in its natural state. This value will become even

APR 30 1969

ASHLAND EYE CLINIC
ROBERT J. SNEED, M.D.   KENNETH A. MORROW, M.D.
1001 SECOND STREET WEST
ASHLAND, WISCONSIN 54806
PHONE: 682-2305

greater with the passage of time. It is very evident that pollution has started from the sources that I have mentioned as well as from the Reserve Mining plant in Silver Bay, Minnesota.

I certainly hope that the conference will take necessary measures to end these sources of pollution as well as other sources around the lake so that this body of water does not end up in the manner as Green Bay, lower Lake Michigan or Lake Erie.

Sincerely yours,

Robert J. Sneed, MD

Robert J. Sneed, M.D.

RJS:ecs

CC: Mrs. Walter Sve, Secretary
East Star Route, Box 120
Two Harbors, Minn. 55616

Mrs. Anne Fancher

MR. DRANGOS: Mr. Chairman, for the record I would like to insert a letter received from Wisconsin Bow Hunters Association, signed by Mrs. Anne Fancher, Secretary. I will not read it.

MR. DOMINICK: That will be received for the record.

(The letter follows.)

WISCONSIN BOWHUNTERS ASSOCIATION
Rt. 2
Crivitz, Wis. 54114

May 2, 1969

Mr. Thomas Frangos, Admin.
Division of Environmental Protection
Wis. Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Dear Mr. Frangos:

We would like this statement to be included in the hearing record at the Federal Water Pollution Enforcement Conference, Duluth, Minnesota, May 13-14, 1969.

"The Wisconsin Bowhunters Association, with a membership in excess of 6,000, is a group dedicated to the ethics of fair chase and perpetuating America's outdoor heritage.

The pollution of our environment and the needless destruction of game and fish habitat is an ever increasing concern to each member.

Lake Superior is the finest and cleanest of our Great Lakes and it must be kept that way. Where waters were once clear along its' shorelines, there is now the grey-green tide of needless pollution.

Pesticides, chemical wastes, paper mills, steel companies, oil refineries, commercial and recreational boat wastes, private septic systems, inadequate municipal sewerage systems are all contributing to an irreversible destruction of this lake. Inadequate state laws and state's competeing for economic advantages are factors that point up the need for this federal conference.

The 60,000 tons of taconite tailings released into this great lake daily by a north shore mining company must be halted. Their Corp of Engineers permit to allow this fill in navigable waters should be terminated. This is the only taconite company that is allowed the economic advantage of not having settling basins and reuse of their waste water.

We urge the present Administration to move forward with orders correcting what could be the death of Lake Superior as we all have come to know it and love it. The law is there, enforce it!!

Yours truly,
Anne Fancher
Mrs. Anne Fancher, Se
Wisconsin Bowhunters

MAY - 7 1969

May 8, 1969

Mrs. Anna Fancher, Secretary
Wisconsin Bowhunters Association
Route 2
Crivitz, Wisconsin 54114

Dear Mrs. Fancher:

Thank you for the statement of the Wisconsin Bowhunters Association that you wish to be included in the hearing record at the Federal Water Pollution Conference at Duluth, Minnesota commencing on May 13, 1969.

We have not received an agenda for the meeting but it appears that Wisconsin testimony will not be presented until May 14 or later. Regardless, we will make sure that your statement is made a part of the record.

Your interest and concern in this matter is appreciated.

Very truly yours,
Division of Environmental Protection

Thomas G. Frangos
Administrator

TGF:fsj

Roger Bodin

MR. FRANGOS: I have a resolution received from the Chamber of Commerce of Bayfield, Wisconsin, Roger Bodin. This was to be presented by Mr. Bodin. He is not here.

(The above-mentioned resolution was read and follows.)

I am Roger Bodin and am delivering this statement on behalf of the Bayfield, Wisconsin, Chamber of Commerce, a civic organization made up of some 100 citizens from Ashland, Washburn, Cornucopia, Port Wing, Bayfield, and LaPointe, which is on Madeline Island, the largest of the Apostle Islands group in Lake Superior.

Natural resources play a vital role in the economy of all of these communities on the South Shore of Lake Superior.

Each one is a city of tourism, and a clean, clear, and blue Lake Superior is the mainstay of the tourism business.

We cannot condone any form of contamination of this priceless resource.

Our organization unanimously supports 100 percent pollution control for Lake Superior.

Industries and municipalities must not be allowed to pollute the lake for economic advantages, as the economics will not balance out when the tourist industry is diminished.

We concur with and endorse the special report on water quality of December 1968 of Lake Superior in the vicinity of Silver Bay, Minnesota, by the United States Department of the Interior, Federal Water Pollution Control Administration, Great Lakes Region.

Roger Bodin

We are convinced that pollutants originating from Reserve Mining Company at Silver Bay, Minnesota, are adversely affecting our shores at Bayfield, and at other communities on the South Shore.

Our organization asks for immediate corrective action on all other sources of pollution around our lake, whether it be from municipal, industrial, or private use.

We request legislation to prohibit all thermal, nuclear, and pesticide pollution of these international waters, and that standards be strengthened and enforced relating to siltation, toxic metals, and shipboard wastes.

Finally, it is also important to remember that ownership of both land and water does not give one the right to destroy them. It is, instead, our responsibility to maintain, as a responsible custodian would, our land and water in order that succeeding generations may also enjoy such resources.

Bayfield Chamber of Commerce members are hopeful that stringent regulatory controls by the Federal Government on all types of pollution of Lake Superior be the result of this conference today.

Thank you for allowing me to appear today and present this statement.

Mr. Chairman, we have received a letter from the Bayfield, Wisconsin, Joint School District No. 1, requesting that this letter and a number of letters that were written by school children and Boy Scouts of that Joint School District No. 1 be submitted for the record.

I will read the letter submitted by Mr. Richard O'Leary, Instructor of Science, and I will ask that the remaining letters be submitted as part of the record at this time.

MR. DOMINICK: They will be received as an exhibit.

(The above-mentioned letters from School Children and Boy Scouts of the Joint School District No. 1, Bayfield, Wisconsin, will be on file at Headquarters, FWPCA. The letter submitted by Mr. Richard O'Leary was read and follows.)

BOARD OF EDUCATION
JOINT SCHOOL DISTRICT NO. 1
Bayfield, Wisconsin 54841

DONALD ANDERSON
SUPERINTENDENT
ROBERT LIND
PRINCIPAL

May 8, 1969

Dear Sir:

The environment in and around the Bayfield area has a geologic heritage that is forever etched in the natural habitat. This beautiful phenomena is enchanced by an added factor and that is the basin in which this community is settled is filled with one of the marvels of the world; the waters of Lake Superior. The complicated ecological chain that exists in this natural habitat has recently been upset by the introduction of an industrial waste into this acquatic environment. The result has been a drastic and continual deterioration of water purity and appearance. Besides the obvious aesthetic desecration is the more important underlying caustic results of pollution, the disruption of the food chain and energy cycle that eventually will affect every living organism in the water of Lake Superior.

The residents of the area as well as transitory guests, are deeply concerned about the problem. We have all seen the results of complacency about water pollution in the irreparable eyesore of Lake Erie, and in the deplorable condition of Lake Michigan's water. These monuments to man's nearsightedness, and thoughtless disregard for conservation and preservation will provide for us the incentive to not only expect, but demand prompt action that will assure a constant state of water purity in Lake Superior.

Because of these reasons and more yet unmentioned the following file is a compilation of themes and statements of concern by the young people of Bayfield, Wisconsin. The Boy Scouts and High School Students sincerely hope that this effort will not go unnoticed. Also included is a signed petition that we have. This will assure the aid necessary to succeed in this cause.

Sincerely,

Richard O'Leary

Richard O'Leary
Instructor of Science
RO:s

Steve Astmann

MR. FRANGOS: The Save Lake Superior Association, Wisconsin Chapter, has indicated they would like to make a presentation at this time.

STATEMENT OF STEVE ASTMANN,
WISCONSIN CHAPTER, SAVE LAKE
SUPERIOR ASSOCIATION, WISCONSIN

MR. ASTMANN: Gentlemen:

My name is Steve Astmann. I am the Director of the Student Union at Northland College.

This statement reflects the corporate opinion of the several hundred Wisconsin residents who now wear the blue and white emblem of the Save Lake Superior Association. Our statement concerns two specific problems, and we also wish to enter a statement of general principle. In addition, we support testimony concerning other problems specific to Wisconsin which will be forthcoming from other witnesses, but with which we will not deal directly here.

A. Reserve Mining Company.

Concerning the taconite tailings being dumped into Lake Superior by the Reserve Mining Company, we wish to state the following:

1. Since the Federal study conducted in the Silver Bay area did not go beyond the 5 by 9 mile perimeter defined for the study

Steve Astmann

in terms of comprehensive analysis, the study fails to prove that interstate pollution by taconite tailings does not exist. Common reason insists that interstate pollution does exist. Lake Superior is a body of water governed by the same principles governing all bodies of water. Materials poured into it in solution or suspension move with the currents of the lake. To suggest that the influence of taconite tailings extends to the Duluth Harbor but does not enter Wisconsin waters is like suggesting that you and I are sitting on opposite sides of a bucket and that although you have poured arsenic in your half, it is all right for me to drink from my half.

There may be an imaginary dotted line drawn across the surface of Lake Superior defining the boundary between Minnesota and Wisconsin, but no one, as far as we know, has yet informed the taconite tailings they are not to cross that line. Because of the capacity of the taconite tailings to remain in suspension for long periods of time before settling out, it is unreasonable to assume they do not reach Wisconsin. We therefore challenge the Federal and State governments to take bottom samples from the Wisconsin shore and prove to us that cummingtonite, the trace metal which identifies taconite tailings, is not present on the Wisconsin side. And until you do, do not talk to us about there being no evidence of interstate pollution.

Steve Astmann

2. It has been demonstrated to our satisfaction that the construction of settling ponds as an alternative to Reserve's present practice is both economically and technologically feasible. It is further apparent to us that the cost of such a program would constitute but a fraction of the annual corporate profits of Reserve Mining and its parent corporations, Republic and Armco Steel.

3. Wisconsin State law described any unnecessary sedimentation of a body of water as pollution. We agree, and are proud of our State's position on this matter. We see no reason why Minnesota should lag so far behind us in this critical matter and grant the Reserve Mining Company license to dump fill into the lake in any quantity whatever, particularly material so abundant in trace metals which are known to provide the basis for accelerated eutrophication of lakes.

4. We object strenuously to the economic inequity which Reserve's present practice constitutes for Wisconsin industry. Being prohibited by law from dumping waste in Lake Superior places Wisconsin industry at an economic disadvantage, and, in fact, it is penalized by having to make a greater investment in a competitive market. Or, to turn the equation around, and place the responsibility where it belongs, Reserve Mining Company is rewarded by the State of Minnesota with increased profits for its practice of polluting Lake Superior. We find this intolerable, and see no reason why it should continue.

Steve Astmann

B. Marine Craft Sewage.

Secondly, we wish to state briefly our concern over the fact that ships and boats operating on Lake Superior are able to use the lake as an open sewer for untreated waste. In an age when we are placing increasing pressure on municipalities to upgrade their sewage disposal systems, permitting such a condition on watercraft is not only inconsistent, it is downright appalling.

We therefore call upon the State and Federal Governments to devise, and enforce, a system of on-ship storage and harbor disposal, or on-ship treatment of wastes, which will bring an end to this gross form of water pollution.

C. Statement of General Principle.

Finally, we wish to enter a statement of general principle.

In numerous cases where questions of pollution arise, parties wishing to continue questionable practices argue that we do not yet know what damage might be done to the ecology of Lake Superior, and therefore to suggest such practices should be prohibited is premature. Perhaps we miss some fine point of consideration, but the logic of this arguement escapes us completely.

If we do not know the effect of our actions, if we are ignorant of what we are doing, then we must request - indeed, as concerned citizens we must demand - to know on what grounds such practices are continued.

Steve Astmann

Hard detergents were on the market for years before their deadly influence required them to be withdrawn. Atmospheric testing of nuclear weapons continued for 20 years before we finally woke up to its destructive impact on the life of this planet. DDT and other persistent, broad spectrum killers had badly polluted our whole environment before we discovered the dangers, and we have not yet resolved to stop using them.

In brief, gentlemen, our recent history is punctuated by one technological mistake after another, the consequences of which were not foreseen, and in every case those consequences, once realized, stand as a judgment on our ignorance.

Our question, then, and our demand is to know how long private and corporate bodies will be allowed to go on dumping their garbage in Lake Superior, all the while pleading ignorance of its impact as the ground for being allowed to continue doing so. We are particularly at a loss to interpret the findings of Federal agencies in relation to the recently published report on Reserve Mining Company's taconite tailings. After listing one hazard after another, the recommendation is made that Reserve be allowed to continue, subject only to semi-annual review. This strikes us as evidence of petty politicking, and hints of covert pressure on those responsible for the report.

At what point, we must ask, will the decision finally be made? Suppose present practices are allowed to continue until suddenly some irreparable damage is discovered. What then? Will we all throw up our hands in despair and claim innocently that we did not know it would happen?

Steve Astmann

No, gentlemen, that is not good enough, and we all know it. The day is past when the people of this Nation will tolerate abusive practices and half-measures to correct them. There is too much at stake. The day is past when people will permit industry to pose as if it were above the common good and the welfare of future generations. The day is past when the people will allow themselves to be subjected to that unique form of blackmail industry employs to silence those who protest their abuses by claiming the cost of cleaning up will have dire consequences to the community. We find particularly obnoxious the threats by industry to lay off workers and move out if forced to clean up. This is childish and petulant. It is to behave like little boys who take their toys and run off to play with someone who will let them degrade the environment free of public interference.

The fact is that the continued abuse of our water and our air constitutes a threat to the future and well-being of our people so vast that no loss of industry, real or imagined, can possibly match it. When dealing with the question of the quality of our environment and with its ability to sustain life, the contention that we cannot economically afford to clean up is a patent falsehood. We cannot afford not to clean up, and no economic consideration is so vital as to justify as its price the destruction of our environment. We may be foolish, but we are not yet suicidal.

Thank you.

Ashland County New Democratic Coalition

(Applause.)

MR. DOMINICK: Thank you for a very excellent statement.

We will take a 10-minute break and meet back here at 4:10 to continue with citizens' statements.

(Whereupon, a recess was taken)

MR. DOMINICK: Will you please take your seats.

Mr. Frangos, are you ready to proceed?

MR. FRANGOS: Yes, I am, Mr. Chairman.

Since I have exceeded the time allotted to Wisconsin, I have other statements that I will submit for the record and will not read.

I have received a resolution from the Ashland County New Democratic Coalition relative to pollution of Lake Superior, and I ask that it be accepted as part of the record of the conference.

MR. DOMINICK: That will be made a part of the record.

(The above-mentioned resolution follows.)

The Ashland County New Democratic Coalition has adopted the following resolution regarding the pollution of Lake Superior:

1. We oppose the indiscriminate filling of Lake Superior by the dumping of waste material such as taconite tailings from the Reserve Mining Company at Silver Bay, Minnesota and fly ash used as fill by the Lake Superior District Power Company at Ashland, Wisconsin.
2. We oppose the pollution of Lake Superior by chemicals as evidenced by the contamination of Boyd Creek at Barksdale, Wisconsin, which condition is caused by material released by the Du Pont Company.
3. We oppose the dumping of inert material such as plastic bits and pieces released into Chequamegon Bay at Ashland by the Marathon Paper Company.
4. We oppose the dumping of raw sewage into Lake Superior by cities, towns and individuals with inadequate sewage treatment plants.
5. We oppose the dumping of raw sewage into Lake Superior by Great Lakes carriers and ocean going ships.

In conclusion, we can see no good purpose to be served by delaying the correction of these and any other pollution problems affecting Lake Superior. We favor immediate action against polluters and suggest a time table be established allowing only the necessary time to construct facilities to provide for other means of disposal of pollutants and waste materials.

Thomas L. Ortman, Chairman
Ashland County New Democratic Coalition

Ernest J. Korpela

MR. FRANGOS: I have a letter received from Assemblyman Ernest J. Korpela, Assemblyman from Ashland, Bayfield, and Iron Counties, with reference to the proceedings at this conference, and I ask that this letter be made a part of the record.

MR. DOMINICK: That will be received for the record.

(The above-mentioned letter follows.)

ERNEST J. KORPELA

Home:
633 3rd Avenue East
Washburn, Wisconsin 54891
Phone: 373-5419

Capitol Office:
325A North
Capitol
Madison, Wisconsin 53702
Phone: 266-1186

WISCONSIN LEGISLATURE
ASSEMBLY CHAMBER
MADISON
53702

Ashland, Bayfield and Iron
Counties

MEMBER:
Committee on Education

699

RECEIVED
MAY 9 1969
Dept. Nat. Res.

May 7, 1969

Mr. F. H. Schraufnagel
Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Dear Mr. Schraufnagel:

This letter is in reference to the public hearing to be held on Tuesday, May 13, 1969 in Duluth pertaining to the pollution problem of Lake Superior and especially the pollutants being drained into the Lake by the taconite industries. I hope this letter will be entered in support of restricting the various industries polluting a lake which is relatively free of pollutants in comparison to the other Great Lakes. Please enter this letter as I will apparently be unable to attend the hearing because the State Legislature will be in session.

It is becoming increasingly apparent that the taconite industry will eventually expand into Northern Wisconsin and expand further in Northern Minnesota and Michigan. It is essential that steps be taken now to require adequate safeguards that this expanding industry return water it uses in as nearly as possible the same purity as what it takes from its source. Requiring such uniformity from State to State and even from industry to industry will make it feasible for every producer to be faced with approximately the same cost factors and increased cost of production.

In that my assembly district covers a major portion of the Wisconsin portion of the Lake Superior Watershed, I feel it is critically important that steps be taken immediately to force a clean-up of our lakes and streams not only in the Lake Superior watershed but across the nation to guarantee a safe environment for our children. A uniformity of standards and enforcement nationwide and even internationally with Canada is of utmost importance to guarantee industry will locate in areas best suited for their growth.

There are many reasons why increased standards are necessary. This letter is simply a reiteration of a belief of many people that America must take immediate steps in controlling a terrific pollution problem which is compounding with our ever-increasing industrial society.

Sincerely,

Ernest J Korpela

ERNEST J. KORPELA
Assemblyman
Ashland, Bayfield, Iron

EJK:js

cc: Richard W. Mihalek

Moquah Men's Club

MR. FRANGOS: I have received a copy of a resolution from the Moquah Men's Club, Moquah, Wisconsin. I ask that this be made a part of the record, please.

MR. DOMINICK: That will be made a part of the record.

(The above-mentioned resolution follows.)

May 5, 1969

Moquah Mens Club
Moquah, Wis.
54860

Mr. Thomas G. Frangos, Acting Adminsitrator
Division of Environmental Protection
Wisconsin Department of Natural Resources
Box 450
Madison, Wisconsin 53701

Dear Mr. Frangos:

The Moquah Mens Club, a civic group very much interested in keeping a healthy and attractive environment for the present and for its future generations, requests that the following be included in the testimony to be made at the FEDERAL WATER POLLUTION CONTROL ADMINISTRATION ENFORCEMENT CONFERENCE - LAKE SUPERIOR BASIN which convenes on May 13 of this year.

It is the firm belief of the membership that action to drastically reduce pollution escalation in Lake Superior is overdue. The once crystal clear water of this great lake is showing visible signs of going the way of Lakes Erie and Michigan. One of the most obvious of the symptoms of pollution is the general apathy that local, state, and federal government has shown in making a sincere effort to stop it. There are unlimited numbers of bulletins, pamphlets, field men and textbooks, all against pollution, and all suggesting how it should be stopped. Still the destruction and death of Lake Erie happened in spite of all of this kind of advice. Lake Michigan will apparently be another historical account of what can happen to a splendid body of water as more advice and studies continue to be offered while government stands idly by. Lake Superior still has a good chance of being kept in a reasonable condition if drastic action is taken now. More studies, or any other delaying tactics won't stop pollution; but enforcement of laws will.

The main thesis of this letter is that the Moquah Mens Club go on record as strongly urging government, especially the Federal Government, to raise all natural water quality standards and to enforce the laws. Only in this way will Lake Superior remain the one last fresh water resource of the Great Lakes.

Sincerely submitted,

Mr. Joseph Johanik, President
Joseph Johanik

MAY - 9 1969

Mr. Walter Johanik, Secretary
Walter Johanik Sec.

cc Mrs. Arlene Harvell, President
Save Lake Superior Association
E. Star Route, Box 117
Two Harbors, Minn. 55616

Roger Bodin

MR. FRANGOS: I have a letter received from the Bodin Fisheries, Roger Bodin, President, and I ask that that correspondence be amde a part of the record.

MR. DOMINICK: That will be received.

(The above mentioned letter follows.)

[illegible]

PHONE (715) 779-[illegible]

BODIN FISHERIES

Fresh Water Fish Distributor and Processor

BAYFIELD, WISCONSIN 54814

MAY 12, 1969

Dear Sir:

I am Roger Bodin of Washburn, Wisconsin and have a commercial fishery in Bayfield, Wisconsin. I am the President of the Minnesota-Wisconsin Fisheries Association and would like to make the following comments on pollution in Lake Superior along with some history. I have lived on the lake for nearly fifty years and have been directly in contact with the water almost daily being the grandson of a fishing family who started fishing in the late 1890's. In the early 1930's we were confronted with two distinct types of pollution in and around the Bayfield, Ashland area. One was the Du Pont plant at Barksdale when the average life of a pound net was only one year, versus five years any where else in the bay, because of

Roger Bodin

the acid content of the discharge from the plant and its reaction to the cotton nets at this time. The other detrement was the bark from pulp logs getting entangled in the gill nets which was very disasterous. We convinced the conservation department that something should be done about this problem and an order was issued that any pulp floated in rafts had to be peeled before shipping, and this was the solution to this problem. The waste acid from the Du Pont plant became less a problem as the years followed because the fishing of commercial fish was prohibited, so there is no proof of the detremental effects on nets since then. Then followed the years of the floods in the 1950's that put so much silt and mud into the lake that even now the water never clears up. Another type of pollution in the early 1960's that was very harmful to our nets was the plastic that was washed into the bay area as the cheapest means of disposal. We are still seeing the effects of this in the nets or on the swimming beaches and it often clogs up the intake tubes of the water cooled engines of boats. Then too we began to get crude oil in our nets similar to tar after the pipe-line was constructed in Superior. It is our belief that this oil drifted to the Apostle Island area due to the counter clockwise drift of Lake Superior. Due to the lack of commercial fishing in the Cornucopia area in the past few years no current information is available on its abundance.

This oil has traveled about 60 miles from its source. We are now confronted with the grey water in and around the Apostle Island area which we believe is due to taconite tailings. We are very concened over this fine dust in the water because from all indications it has affected our herring populations on the north shore and we are fearful of the lack of herring on the south shore as we have seen a rapid decline of this species. Now the latest episode with pesticides and insecticides are our most immediate concern, and we feel that the Federal agencies should control the sale of them since it appears that the States end up without controls due to strong protest from the agriculture and chemical lobbyists? Our commercial fishing industry has had many severe set backs in recent years but far the greatest problem is pollution, whether it be done by industrial wastes, crude oil, taconite tailings, human waste, chemicals, pesticides, insecticides or by any products of industries along the drainage basin. I feel the Federal Govern ent should enforce pollution problems where there is a lack of progress on the State level. Stalling will only make the task more costly. Since Lake Superior is on international waters by having it in the hands of the Federal we can expect more cooperation from Canada.

Certain types of pollution could be helpful to Lake Superior as for fish life as it is too pure and too cold. Thermal pollution could be a help to fish life if it could be controlled, as not to excede a certain temperature. Lake Superior in comparison to the other Great Lakes does not provide much fish per acre because of its pureness and temperature. Certain nutiants would also help if they could be controlled. If there were to be other by-products such as radio active material from thermal pollution it would be much better not dumped into the lake.

I am in hopes that the results from these hearings will speed up the monies promised to the municipalities for sewage disposal improvements and the States immediate action for controls where they now are bogged down in politics. I am proud to be from Wisconsin since I know that much positive action has been taking place this past year and is continuing as fast as monies permit. I sincerely hope that Michigan and Minnesota will pass and start some corrective measures on pollution at once, if the Federal Government is not given the authority to take action. As a representative of one of the major industries of Lake Superior we need positive action now!

Respectfully yours,

Roger M. Bodin, President

Minnesota-Wisconsin Fisheries Association

Wisconsin League of Women Voters

MR. FRANGOS: We have received a statement from the Wisconsin League of Women Voters, and I ask that this statement be made part of the record. I understand that a statement will be made subsequently to the conference, a joint statement of the three Leagues of the three States involved here today.

MR. DOMINICK: That will be made a part of the record.

(The above-mentioned statement follows.)

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STATEMENT TO BE SENT TO DULUTH FOR POLLUTION HEARING; MAY 13, 1969

The League of Women Voters of Ashland strongly urges that the present sources of the pollution of Lake Superior be stopped, and that every effort be made to prevent further pollution.

Industries should not be allowed to dump any of their wastes into the lake; municipalities must greatly improve their sewage treatment facilities; every individual should be actively aware of the necessity for clean water.

There are pollution abatement laws that have to be enforced; we must have tougher legislation for enforcing pollution control on Lake Superior.

It is vital that we accept the responsibility of stewardship for this great resource, so that it may be used and enjoyed by the many generations to come - rather than misused and killed by carelessness.

Gwendolyn F. Jernstedt

Gwen Jernstedt, President
League of Women Voters
Ashland, Wisconsin

Carolyn Sneed

Carolyn Sneed, Water Resource Chairman
League of Women Voters
Ashland, Wisconsin

cc: Honorable John A. Blatnik
Washington, D.C.

Mr. Thomas G. Frangos
Madison, Wisconsin

Mrs. Walter Sve
Two Harbors, Minnesota

HORACE M. HAVNER
Notary Public - State of Wisconsin
My Commission Expires June [illegible]

MR. FRANGOS: I have also received some correspondence from Professor Charles E. Carson, Associate Professor of the Department of Plant and Earth Science at the Wisconsin State University, River Falls, Wisconsin, and I understand he has a statement to be made but that will be made a part of the presentation of the Minnesota Environmental Control Citizens organization tomorrow afternoon.

I believe that concludes the Wisconsin presentation.

MR. DOMINICK: Thank you very much, Mr. Frangos.

Mr. Badalich, we can turn now to you with further witnesses from the State of Minnesota.

We have had discussion among the conferees since my announcement earlier this afternoon and we agree that Michigan will lead off tomorrow morning, followed by other Federal agencies, followed by all interested citizens who have not yet been heard from.

We will turn now to Mr. Badalich and any witnesses which he wishes to call.

MR. BADALICH: Thank you, Mr. Chairman.

To continue with the so-called public witnesses, I would like to call these in this order: the Duluth Area Chamber of Commerce, Silver Bay Chamber of Commerce, the Northeastern Minnesota Development Association, the Babbitt Area Business and Professional Association, and then it would be the United Steelworkers of America, Silver Bay, Minnesota, Conservation Federation, North Star Chapter of the Sierra Club, Save the Lakes, United Sportsmen Club of Duluth, and I think that will probably take the rest of the afternoon.

So if I may call upon Mr. Austin from the Duluth Area Chamber of Commerce.

(No response.)

MR. BADALICH: Mr. Chairman, I have a prepared statement and sufficient copies for the conferees, and we will just introduce it in the record.

MR. DOMINICK: That will be done.

(The above-mentioned statement follows.)

STATEMENT OF THE CHAMBER OF COMMERCE OF THE CITY OF DULUTH, SUBMITTED TO THE FEDERAL-STATE CONFERENCE ON LAKE SUPERIOR, MAY 13-14, 1969

Gentlemen:

I am Daniel D. Austin, manager of the Economic Development Council of the Duluth Area Chamber of Commerce and on behalf of the Duluth Area Chamber of Commerce, and by approval of its board of directors, we submit the following remarks as testimony into this conference.

Pollution of our air, land, and water environment is the collective responsibility of all elements of our society reflected by our ever growing standard of living, demands for new products, improved materials, and our ability to create new technology. Therefore, let's create a partnership where collectively the public, industry, government at all levels, and news media closest to a problem can make up the essential ingredients to attack environmental pollution. It is clear, from what we have heard and seen during the time leading up to this conference, that numerous groups are concerned with pollution of Lake Superior and its tributaries, but have they considered the aesthetic, biological, technical, and economic factors which make this problem complex and interdependent? Or, have they singled out instead an industry, a particular cause, or a special interest?

The Duluth Area Chamber of Commerce is very much interested in the Federal-State Conference which has been called here to consider the problems of claimed pollution of Lake Superior. We are greatly interested in the condition of Lake Superior which is so important to the city and its inhabitants. We are also interested in the various industries and business concerns located near or upon the shores of Lake Superior, the Duluth-Superior Harbor, and the St. Louis River which flows into Lake Superior. We trust that this Conference will not arrive at any conclusions without insisting upon adequate evidence and careful and fair consideration of all the facts.

In connection with this hearing, there have been references to the operations of the taconite plant of Reserve Mining Company at Silver Bay, Minnesota. We believe that unfounded charges have been made against that operation. We trust that there will be careful consideration of all the evidence dealing with this problem by the conferees.

Duluth Area Chamber of Commerce

Reserve Mining Company's operations are of great importance to all of northeastern Minnesota. It has some 3,200 employees. There are two villages--Silver Bay and Babbitt--whose combined populations total between nine and ten thousand, which came into existence because of Reserve's operations, and are entirely dependent upon it.

In addition, there are many concerns which furnish materials, supplies and services. Duluth and the whole area would be seriously affected if there were any unreasonable interference with, or termination of its operations.

In a similar manner, other industries and concerns in the Duluth-Superior harbor and St. Louis River areas being considered at this conference, have great importance to this whole region.

We recognize the importance of pollution studies, but there should be a determination as to whether there is any adverse material effect on Lake Superior from industrial operations and, if so, what remedies there may be. The Duluth Area Chamber of Commerce stresses that any such determinations should be based upon facts, rather than hasty or unwarranted surmises.

The Duluth Area Chamber of Commerce supports water quality improvement of Lake Superior and echoes its policy position as developed for the Governor's Commission Studying Water Pollution in Lake Superior in 1967 which recommended that municipalities and industries be encouraged to solve their pollution problems a step at a time and that they do the following:

1. Become better acquainted with their environment

and their effect upon it. This particularly involves a detailed investigation as to the total effect the wastes that they produce have on the receiving waters and also includes the continual compilation of data necessary to determine if, and to what extent, pollution abatement facilities are needed.

2. Consult with the staffs of Federal and State Pollution Control Agencies as a cooperative effort towards the solution of any pollution control problems if such exists. This will also aid the establishment of uniform proceedures and techniques for sampling, testing, and reporting water quality data.
3. Provide, where feasible, the necessary treatment of waste which would adequately protect the quality of the public waters. Where financial problems arise in justifying the installation of such facilities, industry should apply for tax exemptions under the Minnesota Tax Reform & Relief Act of 1967 (Article XI (11)) and that industry and municipalities should explore all avenues for Federal aid and assistance.

The Duluth Area Chamber of Commerce believes that significant improvement can be made in most instances affecting the quality of Lake Superior's water and its harbor areas. We believe that continued conferences such as this, and continual study of Lake Superior is the proper step that will lead to a satisfactory and workable solution. We pledge to do what we can to encourage private interests, groups, and governmental subdivisions to effect programs that will solve pollution problems. We further believe that only through an understanding and enlightened partnership will the best solutions be found. We maintain that the aesthetic, biolobical, technical, and economic factors must be considered in adoption of time schedules and actual changes that will be required so that a proper social balance can be kept.

MR. BADALICH: The next participant will be Mr. Vernon Larson, Assistant President of the Chamber of Commerce.

(No response.)

MR. BADALICH: We will probably get back to him.

Next will be Mr. Babich from the Northeastern Minnesota Area Development Association.

Is there a Mr. Babich in the audience?

Here he is.

Mr. Babich.

STATEMENT OF ROBERT J. BABICH,
EXECUTIVE VICE-PRESIDENT,
NORTHEASTERN MINNESOTA DEVELOPMENT
ASSOCIATION, DULUTH, MINNESOTA

MR. BABICH: My name is Robert J. Babich. I serve as Executive Vice-President of the Northeastern Minnesota Development Association with an office in Duluth, Minnesota. The purpose of our organization is to develop and expand employment opportunities and to diversify the economics of the six-county region consisting of Carlton, Itasca, St. Louis, Koochiching, Cook, and Lake Counties. Our organization is nonprofit. Our operating funds are derived from subscriptions of labor organizations, major manufacturing companies, iron mining companies, banks, communications media, and retail establishments located and operating in the area. The Assocation was formed during the early months of 1964 and began its activities in November of 1964. The Association is governed by a Board of Directors representing subscribing organizations and areas of our six-county region.

I have been involved with NEMDA since its inception.

Previous to accepting the position as Executive Vice-President of Northeastern Minnesota Development Association, I was Chief of Public Works for 10 north central States for the Department of Commerce. In this capacity I approved over $100 million worth of sewer and water projects to communities, industrial parks, harbors, and recreation improvements. The largest of these projects was the $8 million Cloquet-Lake Superior water line. I am a most sincere believer in water pollution control, and particularly the efforts of the FWPCA with whom I have worked closely during my tenure as Chief of Public Works for the north central States. My testimony is based on my close association with FWPCA and the utilization of the high quality water of Lake Superior as it pertains to industrial development.

Robert J. Babich

Business Conditions Prior to the Development of the Taconite Industry

From the early fifties when the substantial declines in iron ore mining and associated industries began, our region suffered losses of employment opportunitites. During this period when older, experienced men were being laid off and more employment opportunities were disappearing, younger people were forced to leave this area to seek employment opportunities elsewhere. As the depressed era became more firmly implanted in this region, public investment was reduced and a general feeling of pessimism prevailed.

Unemployment in some iron range towns was as high as 19 percent. Even Duluth was hard hit. Youngsters were leaving for better opportunity elsewhere. The region was dying, on the way to becoming a second Appalachia.

It was about 10 years ago when the great Mesabi, supplier of 75 percent of the Nation's iron ore needs, began to play out, starting the exodus of people and talent, energy, and purpose.

With the death of mines and depletion of reserves went a decline in employment in mining and transporation (Hibbing is one of the striking examples of such decline from over 4,000 persons employed, representing one-half of total employment in June of 1953, to about 1,200 persons, and only 1/5 of the total in 1966) and a decrease in tax revenues from mining industry (county and local governments' tax revenues from iron ore in Minnesota in 1966 represented only 59 and 57 percent, respectively, of those in 1957).

Impact of Taconite Industry Development.

In the period since November 1964, which marks the passage of the Taconite Amendment and the many announcements that followed the passage of the amendment, many changes have taken place in our region. Pessimism has been replaced by strong optimism. All types of projects involving public and private funds have blossomed.

Investments in taconite plants have totaled over a billion dollars in the region. By 1990, investments are estimated to reach $2 billion. Capital investments on an annual total expenditure basis will increase by nearly $75 million each year until 1975, and then drop to $33 million increase per year through 1990. The cost of labor was $120 million in 1965, is estimated at $130 million for 1975, and will reach $150 million by 1990.

Even though the progress just indicated is substantial, probably the most important dividend of the taconite industry is the proliferation of "satellite industries" which have located in the region due to the large equipment and material purchases required by the taconite mining industry. These diversified manufacturers could prove as great a benefit to the region's economy as the giant taconite industry itself. Any adverse influence can delay this tremendous potential development.

Robert J. Babich

Satellite Industries

Due to the extreme hardness of taconite rock, equipment wear is severe and replacement becomes an expensive undertaking. It has been estimated that approximately 10 pounds of steel is worn away in pelletizing process alone for each ton of taconite produced. In 1965 estimates of expenditures and supplies for the Erie, Reserve, and Pilotac plants totaled nearly $63 million.

By 1975 this annual expenditure should jump to $165 million and $250 million by 1990. Clearly this is a large potential market waiting to be tapped by associated industries.

NEMDA Satellite Industry Report.

The current impact of the taconite industry is highlighted in a survey recently taken by NEMDA that indicates the economic impact of the taconite industry is substantially greater than the benefits resulting from new construction and new operations alone.

The survey shows that the new taconite industry provides a very large market for products made and distributed in this area and for services sold by various firms. The survey covers 140 area firms and shows that sales to the taconite industry exceed $112 million annually.

Sales to the taconite companies include such items as blasting agents, grinding and crushing equipment, industrial machinery, engines, tires, electrical equipment, fuel, repair services, and many other items that are necessary in the operation of taconite mines and plants. The firms which supply the taconite companies emply 3,466 persons. The taconite companies themselves employ 8,425 on a year-round basis.

The survey results have disclosed that 28 area firms have plans for expansion and one new firm has already begun production of grinding equipment for taconite operations.

Natural ore operations employ 5,175 people, bringing the mining industry employment total to 13,600. Taconite payrolls amounted to $85 million last year, while the payroll in the natural ore industry came to over $52 million. The total industry payroll amounts to over $137 million.

The survey also disclosed that sales of supplies and services to the natural iron ore industry amounted to close to $19 million brining the total economic impact of the iron mining industry in the area to $289 million. These are service industries, not counting the taconite sales, bringing the total economic impact of the iron mining industry to $289 million and it can only be the begining.

The NEMDA report stresses that these are present figures and that continued expansion and growth in the taconite industry as well as in supporting industries can be anticipated; and let's hope they do.

Robert J. Babich

Economic Impact of Reserve Mining Company.

The Reserve Mining Company operation at Silver Bay, Minnesota, on the shore of Lake Superior plays a very important role in the economy of northeastern Minnesota. Its direct payroll last year was over $29 million. It paid taxes in the amount of $3.7 million. It provided more than 3,200 year-round jobs. In addition, its annual expenditures for goods and services have meant much to the other industries in the whole area. In fact, it is the principal support for the villages of Silver Bay and Babbitt with combined populations of close to 10,000 people. And the Government is talking about new towns. These are new towns with 10,000 full-time, year-round workers.

In a letter to the editor of the Mesabi Daily News, Mr. Glenn E. Peterson, Director of the United Steelworkers of America Union in Duluth, points out that Reserve Mining Company has studied this matter of pollution of Lake Superior quite thoroughly. "Testimony of independent expert witnesses was taken and the same questions were raised as are being raised now. At the conclusion of these hearings, Reserve was granted permission to proceed with the present method of depositing the grindings." He recommends that all opinions and judgments be withheld until such time that this matter be clarified on the basis of facts. A hearing must be based on these facts and follow the procedures of a sole issue, that of determining if the depositing of grindings actually harm Lake Superior.

Robert J. Babich

Tourism

Important in the ever-growing activity in our region has been the development of our recreational resources. We have encouraged the full utilization of these resources and the additional investment necessary to improve and modernize facilities that have suffered from age and are on the verge of outliving their usefulness. In short, our program has extended the full range of economic development activity, and it has been planned and executed so as to develop a spirit of interest and cooperation rather than jealous competition.

NEMDA has never received an unfavorable comment relative to pollution in Lake Superior. Lake Superior has no floating debris, obnoxious odors or unsightly, unnatural colored waters.

Conclusions

In summing up this testimony on behalf of the industrial development interests in northeastern Minnesota, I feel strongly that industry has progressed to the point where plants of all types will be completely compatible with the scenic and recreational advantages this region is widely known to have. Industry in northeastern Minnesota has expressed their desire and interest to do everything possible to work out the best solutions to the water pollution problem. Reserve Mining Company, along with others, have continuously supported the idea of developing programs that will serve to eliminate pollution effects.

Robert J. Babich

Speaking on behalf of industrial development, I feel the emphasis currently placed upon pollution control that specifically singles out an operation so vital to this area's economy should not overshadow the attention that should be given to attracting industry to this region. The impact of the potential we anticipate is just too great to jeopardize with the undue attention being given to preliminary reports relating to pollution problems in Lake Superior.

In closing, I urge that every consideration be made to permit the fair treatment of industry to provide new employment opportunities and economic development so badly needed in our region. If this is granted, we will be better equipped to maintain and develop for future generations the beauty, recreational advantages, and industrial opportunities that are so important to our economy. Certainly any failure to achieve these ends will reflect an echo for years to come on any future economic development activities within the entire State of Minnesota.

It is most disturbing to developers in development organizations such as ours who work so hard to create an image for an area that has had a history of economic instability, to be confronted with such undue emphasis from a preliminary or incomplete pollution report. Reserve Mining Company and other industries in northeastern Minnesota are most aware of the high quality water control. In their desire to comply with water pollution regulations, Reserve Mining Company, before investing millions of dollars in the economically depressed North Shore area, did considerable research with the State and Federal authorities before proceeding with construction of the present facilities.

It is unfortunate that a preliminary or incomplete report could stimulate such embarrassment to a company that has shown confidence in northeastern Minnesota and has complied with all regulations of the water pollution control authority. It is my hope that the water pollution control authorities, both Federal and State, will proceed on an intelligent research basis as has been consistent with their program. It would be most disastrous if the quality of Lake Superior water becomes a political football.

Well-planned industrial development is conducive to water pollution control. We must look at the constructive attributes from industrial development. A balance between water quality standards set by the law and the need for industrial development to create jobs is an example. I have put in many projects in Wisconsin communities that never had treatment facilities, and with the activated industrial parks and industries the entire town now has water treatment facilities. That is the involvement of industry and their contribution to water pollution control.

The city of Duluth, the Mayor and the City Council, because of the demand of industrial development, have, for the first time, a study going on to upgrade their treatment facilities, and why? - because of the industrial expansion involvement in Duluth.

Robert J. Babich

The North Shore Highway, which is half a mile from Lake Superior, prevents any runoff, which is considerable in pollution, because the installation of Reserve Mining Company is there, and that is why you have a 4-lane highway there.

This is incidental involvement of water pollution control by industry.

I might state my own experiences. I look back to 1944. We had a chicken coop and a rabbit pen in our yard. I was 9 years old in a family of 10 kids in 1935. My dad's average was 6 years of employment. The last 2 years he worked 2 days. In 1946 I returned from Europe in the service. We put in a gas stove and an electric stove. This is a form of pollution and the economics involved in water pollution control.

I recently attended a conference in Minneapolis where they used a slogan to raise money for the arts and symphonies - violins, and paint brushes - and the importance of cultural interests to attract industry in an area. A slogan is apropos between industry, FWPCA, jobs, chicken coops, and outdoor privies. We don't want a puritanism so no industry will develop between the shores of Wisconsin and Minnesota. How do you explain to people in Cloquet if you said Japan is buying timber from Montana and dumping their finished product in the United States? How do you explain to the unemployed miner in the country in Wisconsin that his ore could be processed in Canada? And how do you explain in the city of Duluth when each year we have Canadian wheat for Canadians by the thousands who buy in Duluth? In the next 20 years are we going to have a Minnesota Day in Wisconsin?

We have worked for the last year on a gaseous diffusion plant - 8,000 construction workers - but I am told by a so-called expert, without any facilities, without any research, that the thermal temperature will be increased. At least they deserve a hearing on this. This is no reference to the FWPCA. These people are very sincere in their efforts.

In conclusion, I would like to say as a result of this meeting and the publicity in the last 6 months, two apologies are in order, I feel, 1) to the dedicated people involved in the State, Federal, and local levels who are sincere in their efforts in water pollution as I am, and, incidentally, not even having the opportunity to complete their research; and 2) to the Reserve Mining Company, who have shown confidence in this area after the people of Minnesota showed confidence in the potential of the mining industry, invested millions of dollars, and have had to listen to what we have listened to for the past 6 months.

I thank you very much.

MR. DOMINICK: Thank you, Mr. Babich, for a very forceful statement.

We do have a question.

MR. PURDY: Mr. Babich, you have made reference to the fact of the expanding allied industry. I wonder if you feel it would be appropriate for the expanding taconite industry, as well as the existing industries throughout the whole Lake Superior Basin, to dispose of their tailings into Lake Superior. Do you think this would be appropriate?

MR. BABICH: Would you repeat that? I did not hear the question, sir.

MR. PURDY: You refer to an expanding taconite industry and the harmful effect that might occur to this particular company if they had to do anything different than discharge their tailings into Lake Superior. I am wondering if you feel that it would be appropriate for the entire taconite industry to enjoy the same economic advantage, if one exists, and discharge the tailings from the full taconite industry in the Lake Superior Basin into Lake Superior?

MR. BABICH: I did not make the statement that tailings would create this problem. I don't know, as many of us here do not know - most of us I should say. As for the remainder of the industry that is expanding or anticipating expansion of dumping their tailings into Lake Superior, this would not become a necessity. Again I refer to the economics of the North Shore and why the plant was located with the availability of water. I don't think I have every suggested a plan to dump all tailings, nor is it a suggestion that has been made by any other industry on the Iron Range complex, anticipating expansion, of ever disposing of their tailings in this fashion. The need isn't there, sir.

MR. PURDY: We have a growing industry in Michigan and in their case they are required to dispose of their tailings on the land at a cost to their production, and I am wondering if you feel it would be appropriate that they also discharge their tailings into Lake Superior?

MR. BABICH: I understand they are dumping some tailings in Michigan - the copper industry. I think we are pointing a finger at one industry. I understand in Ashland, Wisconsin, the community dumps ash as a residue from the plant into Lake Superior, which has definitely acids involved. I am not familiar with the situation in Michigan. There is a possibility that water was available in the plant. I did build the plant, incidentally, at Republic, Michigan. I am fairly familiar with the Negaunee area. There are possibilities that water supply was available, but it was not necessary to do this.

MR. PURDY: I think you have answered my question.

MR. DOMINICK: Are there any further questions?

(No response.)

MR. DOMINICK: Thank you again, Mr. Babich.

If we may continue with the Minnesota presentation.

Next, I would like to call on the representative of the Babbitt area Business and Professional Association, then next I would like to call on the Minnesota Conservation Federation, United Steelworkers of America, and then the North Star Sierra Club.

Is Mr. Harold Johnson here from the Babbitt Business and Professional Association?

(No response.)

MR. DOMINICK: If not, we will continue.

I next call upon the Minnesota Conservation Federation.

STATEMENT OF JAMES T. SHIELDS,
EXECUTIVE DIRECTOR, MINNESOTA
CONSERVATION FEDERATION, MINNESOTA

MR. SHIELDS: Thank you, Mr. Chairman.

Conferees, ladies and gentlemen:

I am James T. Shields, Executive Director of the Minnesota Conservation Federation.

The Minnesota Conservation Federation has about 100 affiliated clubs and 10,000 individual members from throughout Minnesota. We are the largest conservation organization in the State and are affiliated with the National Wildlife Federation, and that is about 2,500,000 members.

There are many voices in our membership that speak loudly and clearly against all forms and degrees of pollution. They must be heard, for without them we could rapidly compromise our resources for the mere sake of expediency and immediate material benefit.

Today, however, even at the risk of offending some of these voices, we wish to propose practical guidelines for limiting the pollution of Lake Superior caused by the taconite beneficiation plant at Silver Bay.

Before outlining these guidelines, we should focus our attention on the salient factors which have been gleaned from the reports and studies done by both the State and Federal agencies. Unfortunately, a great deal of misleading information has been heard concerning these matters.

1. The original permits issued to Reserve Mining Company to operate the taconite beneficiation plant at Silver Bay provided for the dumping of tailings in a specified area of the lake. The potential chemical pollution from these tailings was taken into account but was determined to be negligible in its influence on aquatic life. The "permissible pollution," then, was that resulting from the filling of a portion of the very deep trough that is located a short distance from shore and the narrow corridor between the taconite plant and this deep trough.

2. The Reserve Mining Company proceeded with final development of the plant at Silver Bay in the belief that the terms of the permits would be met through the planned operational procedures.

James T. Shields

3. In the 13 years the taconite plant has been operating it has become increasingly evident that not all of the tailings are settling in the deep trough offshore from the plant. The finer particles are drifting with the lake currents and are being deposited as far as 15 miles downshore.

I might add there that, in my opinion, at least, it is ridiculous for anyone to deny that that is not a violation of at least the intent, if not the legal weapon, of the operating permit.

At times this drifting of the "fines" increases the turbidity, causes a marked discoloration of the water, and reduces penetration of life generating sunlight. The deposition of the fines changes the physical composition of the bottom soils and somewhat alters the production of certain bottom-dwelling organisms which provide part of the diet of some species of fish. The ultimate effect on the production of fish, however, is apparently more theoretical than actual.

4. There is yet no solid evidence that the fines have had any appreciable toxic effect on living organisms in the lake. Neither is there evidence that the fines have had any direct adverse effects on fish, fish fry, or fish eggs. It should be noted here that the laboratory experiments that have suggested that fish eggs or fish fry are injured by these fine particles have been done with extremely heavy concentrations of tailings which are found in the lake only in the immediate discharge area of the plant.

5. The excessive amounts of certain chemical elements, such as copper and zinc, that exist in the tailings apparently are in forms that are virtually insoluble and inactive and therefore pose only a theoretical threat of pollution. The possibility of these chemicals ever having a measurable adverse effect on aquatic life in Lake Superior is virtually nil.

We may conclude from these essential factors that in terms of the permit the unpermissible pollution resulting from the operation of the taconite beneficiation plant at Silver Bay is associated entirely with the "renegade fines." These fines drift downshore causing objectionable discoloration of the water. They also limit to some degree the production of some fish food organisms by decreasing the penetration of sunlight in the water and by changing the physical composition of the lake bottom.

Three possible solutions are immediately suggested: (1) close down the plant; (2) pump the tailings inland; or (3) eliminate the fines from the tailings so that the deposition will occur in the lake as originally planned and in accordance with the intent of the permit.

Speaking of No. 1, closing down the plant obviously should be considered only if a satisfactory solution to the pollution or disposition problem cannot be found.

Pumping the tailings inland would have results which are just as objectionable as the pollution of Lake Superior. The contours of the land in this area are such that Lax Lake would certainly be ruined by the deposition of tailings inland. This 200-acre lake supports a fine sport fishery and is considered to be a valuable recreational area. In addition to Lax Lake, the potential disposition area forms a major portion of the watershed of the Beaver River. It seems certain that this fine trout stream would be adversely affected, if not entirely ruined. Thus, pumping the tailings inland from the Silver Bay plant would only transfer the pollution problems from one area to another.

Removing the fines from the tailings before they are deposited into the lake is technically possible and is, therefore, the only practical solution. This would reduce the deposition of tailings in Lake Superior to the "permissible" amount allowed by the original permits. And although even that amount may be considered objectionable by some, it is the only fair way of facing the problem at this time. We should, however, limit the period this will be tolerated and reject plans for similar operations in the future.

In summary, the following guidelines are suggested:

1. Allow the present operation to continue for only a brief period, such as not more than 18 months, after which further permit renewals will specify that only the larger particles may be deposited in Lake Superior. In effect, this gives the mining company ample time to develop a method of removing the finer particles from the tailings. Any further pollution of the lake that may occur during this limited period will be negligible except for the discoloration of the water.

2. Establish a definite time limitation for the operation of the Silver Bay plant which will allow the company to depreciate its investment.

3. Let it be clear to all concerned that there will be no further permits issued for operations which would use Lake Superior as a dispose-all, regardless of how chemically inert the dumpings may be or how rapidly they settle to the depths where we cannot see them.

The Minnesota Conservation Federation is, of course, also concerned about the many other types and sources of pollution occurring in Lake Superior. We will strongly support measures that may be taken to eliminate or reduce such pollution and thereby maintain Lake Superior as the crown jewel of the Great Lakes.

Thank you, Mr. Chairman.

(Applause.)

MR. BADALICH: Are there any questions?

MR. PURDY: No.

MR. BADALICH: Next, I would like to call upon Gene Roach, representing United States Steelworkers of America, Silver Bay.

(No response.)

MR. BADALICH: We will pass on to Mr. Richard Thorpe, who is representing the North Star Chapter of the Sierra Club.

Richard J. Thorpe

Mr. Thorp.

STATEMENT OF RICHARD J. THORPE,
CHAIRMAN, NORTH STAR CHAPTER,
SIERRA CLUB, ST. PAUL, MINNESOTA

MR. THORPE: Mr. Chairman, conferees, ladies and gentlemen:

I am Richard Thorpe of St. Paul, Minnesota. I am Chairman of the North Star Chapter of the Sierra Club.

The Sierra Club was founded in 1892 "to explore, enjoy, and preserve scenic resources of the United States." The Sierra Club is one of the Nation's oldest conservation organizations, playing a prominent part in the effort to preserve major scenic and natural resources. The Sierra Club today has a nationwide membership of over 78,000. The North Star Chapter in Minnesota has grown to 650. I might comment that this interest in the Club in Minnesota has been generated in the last year or so.

At a meeting of its national Board of Directors in San Francisco on May 3-4, 1969, the following resolution was adopted:

> "The Sierra Club urges that all measures be taken to preserve and maintain the quality of Lake Superior's water, and it pledges to cooperate with its Midwest chapters in pursuing this goal."

I might comment, to carry out that resolution the Board of Directors appointed a three-State committee, consisting of two Sierra Club leaders from Michigan, two from Minnesota, and two from Wisconsin. They will be working on the national staff on this problem.

Another thing the organization will be doing is preparing one of its format books, such as they have done in other conservation areas like the Grand Canyon and the Redwoods.

We feel that it is fitting that a national organization express its concern over the matter of preserving the water quality of Lake Superior. The lake is a major national resource. The fact that it borders on only three of the 50 States makes it mandatory that these States, and the Federal Government, act as trustees for the benefit of the citizens of all the States and exert every effort to preserve Lake Superior in its present relatively unpolluted state. To this end the most stringent of water quality standards for the lake must be adopted and firmly enforced.

In an earlier time we could grant to polluters a measure of leniency and the benefit of the doubt. In 1969, however, when Lake Erie is dead, Lake Michigan is dying, and Lake Superior is threatened, and when on all fronts man is assaulting his environment with ever-increasing ferocity, this attitude must change or our descendants will pay an incredibly high price for our sloth.

We, therefore, call for the adoption of the principle that no industrial or municipal waste discharge to Lake Superior be permitted which has an adverse effect on the ecology of the lake.

We also call on the various State agencies, particularly the Minnesota Pollution Control Agency, to exhibit a greater concern over the threat to the lake.

The 1947 permit granted to Reserve Mining Company by the State of Minnesota was granted upon the condition that tailings should not be discharged so as to result in any material clouding or discoloration of the water at the surface outside of a specified zone. The permit also imposed a condition that the tailings should not be discharged so as to result in any material adverse effects on fish life. As you know, other conditions were also imposed.

Both the controversial December 31, 1968, unofficial report of the Department of the Interior interagency study group and the official April 1969 report of the Department of the Interior indicate that there may well be sufficient evidence to warrant a finding that the conditions of the 1947 Minnesota permit are being violated. However, instead of expressions of concern from the Minnesota Pollution Control Agency, we get repeated knee-jerk reactions, summarily refusing to acknowledge that the conditions of the Minnesota permit are possibly being violated. We feel a more reasonable response would be a call for a public hearing on possible revocation of the permit for violation of its conditions and the immediate undertaking of further in-depth studies.

Richard J. Thorpe

You have heard various comments, pro and con, on the portion of the on-shore disposal of Reserve Mining Company's taconite tailings. There is an obvious disparity between their estimates and that of the private or the Federal Bureau of Mines. Obviously, this is an area of fact here that should not be conjectured upon, but should be studied by the Federal Government to determine if this is really economically feasible. We don't feel that it should be rejected at this point.

Great in-depth studies of the cost of on-land disposal of Reserve Mining Company's taconite tailings should be undertaken immediately. The unofficial report, in Part II, suggested an initial capital outlay of $7.5 million for 3 years of production and annual operating costs of $3.3 million. In a statement of April 1, 1969, Reserve Mining Company estimated capital costs well in excess of $250 million and annual operating costs of $13 million. Such a wide disparity in figures indicates the need for further study. The possibility of on-land disposal should not be rejected.

The preservation of the water quality of Lake Superior merits the highest of priorities on a national scale of values. The operation of any industrial plant or municipal waste disposal plant should not be in conflict with this goal.

Thank you.

(Applause.)

MR. BADALICH: Next, I will call on Mr. Milton Pelletier representing the United Northern Sportsmen Club.

Milton Pelletier

STATEMENT OF MILTON PELLETIER,
UNITED NORTHERN SPORTSMEN CLUB,
DULUTH, MINNESOTA

MR. PELLETIER: My name is Milton Pelletier, and I appear here to deliver this paper on behalf of the United Northern Sportsmen, a conservation club with a membership of over 800 persons residing in and adjacent to the city of Duluth. My position with the organization is past president, trustee, and member of the Study Committee.

The United Northern Sportsmen Club, from its very inception over 20 years ago, has been in the foreground of the fight against water pollution and against other plundering of our natural resources. Our fight has been nonpartisan in scope and based on several beliefs, which we wish to share with you:

1. We believe that the habits of a Nation will finally determine its destiny. If we choose to pollute our waters, however it may be justified, or allow our land to erode, or to bury our country under tons of litter, or to allow other natural resources to be plundered, we are heading toward ruin and no amount of money will repair the damage.

2. We believe that every individual has a personal and continuing responsibility and a equity in all our natural resources, including water - but there is, indeed, a much heavier

responsibility upon those elected and appointed public servants charged with cleaning up our environment.

3. We believe that land or water ownership is merely a life tenure of custodianship to be passed on to succeeding generations, and that such ownership or custodianship does not carry with it the divine right to destroy.

4. We believe that everyone must have a reverence for the land and water and its fruits not based on profit motive. Any other course leads to exploitation and destruction, as we have learned, to our sorrow.

5. We are a conservation club and believe in the wise use of our natural resources. We believe it is much cheaper to prevent pollution than to clean up the results. It should not be permissable to dump anything desired into public water and then set standards juding the results of such abusive practices. Control should occur before disposal.

We have been steadfast in the pursuit of these ideals. The club has grown and prospered these many years because of our consistent adherence to them. We have been recognized State-wide and nationally for our sane and capable fight to secure the benefits to mankind expressed in the above-stated creed.

We need and want industry, as most of our members depend on industry for a livelihood. There is no question that industry can operate profitably in our area in a manner assuring no natural resources will be plundered or needlessly destroyed.

We can cite instances of companies consulting with us when their plants were being designed so as to assure protection of our water resource. We have been proud to join with our affiliate, the Minnesota Conservation Federation, in making awards recognizing "applied sound water conservation principles" by industry. Many companies are now following this example, and we applaud them one and all.

We do not appear here as interpreters of technical reports, nor do we appear as technically trained experts. Either course would be presumptuous on our part. We do, however, appear as interested citizens, citizens who appreciate the value of this great reservoir of fine water both locally and nationally, and want to take no chance whatever that it will be destroyed. We want no misunderstanding on our position. So that it will be crystal clear, it is summarized as follows:

1. It is an undisputed fact the St. Louis River, the first major tributary to the lake, is being polluted by municipal, industrial, and natural wastes. We want the sources of pollution identified, and we see no reason for further delay in implementing a vigorous and prompt program of pollution correction and control immediately.

2. Municipal, industrial, and marine wastes are adding their contaminating influence daily to the Duluth-Superior Harbor. In our desire to restore the aesthetic value of a clean and fresh body of water (to add to the value of our city's very fine cultural, recreational,and educational facilities) we must

identify the sources of pollution and call upon our State and Federal officials and agencies to use every means available to either stop or curtail this insidious poisoning of what could well be Duluth and Superior's finest resource.

3. Many private cabins or homes are located so close to the shore, or have disposal systems so ineffective that seepage is directly polluting the lake or ground water sources. We want an ambitious program instituted by the State Water Pollution Control Agency as soon as possible to remedy this situation.

4. If the proposed location of a nuclear breeder plant on Lake Superior would have any adverse effect on the quality of the water in the lake, we would be opposed to it. All questions of feasibility and possible constructive uses of the heat generated by such an installation should be answered in advance and not after the construction of such an industry.

5. The United Northern Sportsmen have consistently opposed the disposal of taconite tailings in Lake Superior. At times we have stood almost alone in our opoosition. We believe this practice should be stopped and an alternate method of disposal employed. Until such changes are made, the State should enforce the present permit which specifically prohibits any material clouding of the lake, and grant no liberalization of same beyond the permit limits. Any statement that this company cannot operate unless allowed to dispose of waste in Lake Superior is

debatable, because other companies are doing it and competing successfully. We also call upon the U. S. Army Corps of Engineers to require on-land disposal of tailings at Silver Bay as recommended in the U. S. Department of Interior report dated December 31, 1968.

6. Siltation by construction and poor agricultural practices is a major contributing factor to pollution in Lake Superior. The problem areas should be pinpointed and immediate steps taken to institute sound soil conservation practices.

7. All other sources of pollution around the lake, either from feeder streams, municipal, industrial or private uses, deserve immediate and determined corrective action.

8. And, finally, we urge a review of the water quality standards adopted for Lake Superior in that they be strengthened to prohibit all thermal, nuclear, and pesticide pollution, and to tighten the standards relating to siltation, toxic metals, and shipboard waste.

The fine results of the introduction of Coho Salmon to Lake Michigan reveal what can be accomplished when concerted action is taken. The cloud of doubt now suspended over the future of this endeavor illustrates very vividly what damage may be caused by the indiscriminate use of pesticides and shoddy methods of waste disposal.

Milton Pelletier

Those who consider the above outlined program as being too unrealistic or stringent to achieve should remember how old methods have failed. We know by very bitter experience how even a little pollution is prone to collect in unexpected places and manifest itself in some very unpleasant and unexpected ways. Lake Superior, for all its vast area, depth, and coldness of water, is most assuredly not immune to the ills that have served to cause such havoc in so many other lakes.

Finally, we want no more studies simply to prove the lake is becoming more polluted and which are dictated by political expedience, but solely on what is good for the lake environment in the long run. Surely we now possess the degree of technical knowledge and competence to prevent the ruin of this water as has been the case in so many other areas. The saddest picture I have ever seen was a cartoon picturing a water hole surrounded by an elephant, lion, zebra, and several other animals. The lion speaks, "We are no longer a backward Nation this water hole is polluted." What a shame and strong resolve this should evoke! The implementation of present technical knowledge and fair, yet rigid, enforcement of present laws and regulations could prevent that if our administrators have the will to do so. The United Northern Sportsmen are proud of this conference and feel that a great amount of good can derive from this extraordinary hearing. We assure you of remaining ever constant in our battle for a better America, and we stand ready to assist each and every one of you in any way within our means to preserve for posterity this priceless Lake Superior - "The Crown Jewel of America."

Thank you for permitting us to appear and present our views.

Attached for your files is a copy of our letter of November 18, 1968, addressed to the Honorable Stewart Udall urging his calling of this conference.

(Applause.)

MR. DOMINICK: Thank you, Mr. Pelletier. That letter will be made part of the record.

(The above-mentioned letter follows.)

Request for

WATER QUALITY ENFORCEMENT CONFERENCE OF LAKE SUPERIOR

by

UNITED NORTHERN SPORTSMEN

746

Conservation Pledge
I GIVE MY
PLEDGE AS AN AMERICAN
TO SAVE AND FAITHFULLY TO
DEFEND FROM WASTE THE
NATURAL RESOURCES OF
MY COUNTRY — ITS SOIL
AND MINERALS, ITS
FORESTS, WATERS,
AND WILDLIFE

United Northern
SPORTSMEN'S CLUB
MINNESOTA'S LARGEST AND MOST ACTIVE CONSERVATION CLUB

To all organizations and individuals who recognize the need for definite standards of cleanliness to be established for Lake Superior as soon as possible.

Attached for your information is a copy of a self-explanatory letter addressed to Mr. Stewart Udall, Secretary of Interior. We urge that you support our request and that you make your views known to Secretary Udall promptly.

We would appreciate a carbon copy of any correspondence in reference to this subject for our files.

Your cooperation will be very much appreciated by The Study Committee of the United Northern Sportsmen Club, Mr. E. C. Pearson, Chairman, 2202 Hillcrest Drive, Duluth, Minnesota 55811.

Committee members: Harold Sims, Lyell Brand, J. Wesley White, Dolphe Johnson, Robert Anderson, Bud Haug, Harold Edstrom, and Dennis Kreuth.

Milton Pelletier
President, United Northern Sportsmen
3680 Munger Shaw Road
Duluth, Minnesota 55810

United Northern Sportsmen are organized for the following purpose: To improve conservation and to increase our game and fish by legislation, or other legitimate means, and endeavor to provide education for its members and our children by their understanding of the Fish and Game Code, and to guard against Poachers and others who infringe upon the laws of the State. To enforce existing laws and secure the repeal of those that are unjust.

November 18, 1968

Honorable Stewart Udall
Secretary of Interior
Department of the Interior
Washington, D.C.

Dear Mr. Secretary:

This letter is written on behalf of the members of the United Northern Sportsmen's Club Minnesota's largest and most active Conservation Organization. At present we boast a membership of over 600 persons, in all walks of life residing in and adjacent to the city of Duluth. On a broader scale, we are affiliated with the Minnesota Conservation Federation, a statewide organization, and nationally with the National Wildlife Federation.

The United Northern Sportsmen Club, from its very inception, over twenty years ago, instigated the fight, locally, for pure water and pure air. At that time, we were a small voice crying in the wilderness. We were ridiculed for our ideas, threatened, as well as withstanding other methods of intimidation. However, we are a stubborn group. We love this north country, and we intend to make it our lifetime home. We can think of no finer place on the face of the earth for our children and our children's children to live.

The above is not written for the purpose of glorifying the club in your eyes, but simply to give you a thumb-nail sketch of our organization and perhaps serve as a crutch for later requests for your assistance.

We do not want you to believe that we are the only organization in Northern Minnesota interested in prevention and control of pollution--we are not. Neither do we wish you to believe that every individual in Northeastern Minnesota who believes in the prevention and control of pollution and wants to participate in attaining pure water and air belongs to the United Northern Sportsmen Club, they do not. However, we do believe that our efforts have been the best coordinated and of the longest duration!

As you know, this Lake Superior Country is a relatively newly developed area; although old, from the standpoint of history; the first French Explorers approaching the great inland sea by way of the Ottowa River and Lake Huron knowing nothing of the connection of that lake with Lake Erie; referred to their discovery as "Le Lac Superieur." Properly translated, the expression should be "Upper Lake", that is, the lake above Lake Huron. But the English name, denoting size, depth, et el, superiority, seems more apt in many ways.

The first explorations of the lake were made prior to 1623 and may have preceded any settlement on the Atlantic Sea board. By 1658 there was a fairly accurate map of Lake Superior. Oddly enough, Lake Superior was discovered and explored before Lakes Michigan, Erie and Ontario.

Following exploration there was fur trading, fishing, mining, and lumbering operations carried on, on the shores of Lake Superior, but presumably little was done to destroy either pure air or pure water. People began moving in and settlement of the north shore dated from the Indian Treaty of 1854.

In June 1870, William Francis Butler, later to become Sir William Butler one of the great soldier-adventurers and writers of the nineteenth century, visited Duluth and the shores of Lake Superior. His description of the lake as taken from his book "The Great Lone Land" follows:

> "Before turning our steps westward from this inland-ocean of Lake Superior, it will be well to pause a moment on the shore and look out over its bosom. It is worth looking at, for the world possesses not its equal; four hundred English miles in length, 150 miles across it, 600 feet above the Atlantic levle, 900 feet in depth--one vast spring of purest crystal water, so cold, that during summer months its waters are like ice itself, and so clear, that hundreds of feet below the surface the rocks stand out as distinctly as though seen through plateglass. Follow in fancy the outpourings of this wonderful basin; seek its future course in Huron, Erie, and Ontario, in that wild leap from the rocky edge which makes Niagara famous throughout the world. Seek it further still, in the quiet loneliness of the Thousand Isles; in the whirl and sweep of the Cedar Rapids; in the silent rush of the great current under the rocks at the foot of Quebec. Aye, and even further away still, down where the lone Laurentien Hills come forth to look again upon the water whose earliest beginnings they cradled, along the shores of Lake Superior. There close to the sounding billows of the Atlantic, 2000 miles from Superior, these hills--the only ones that ever last--guard the great gate by which the St. Laurence seeks the sea.
>
> There are rivers whose current, running red with the silt and mud of their soft alluvial shores, carry far into the ocean, the record of their muddy progress; but this glorious river system, through its many lakes and various names, is ever the same crystal current, flowing pure from the fountain-head of Lake Superior. Great cities stud its shores but they are powerless to dim the transparency of its waters. Steamships cover the broad bosom of its lakes and estuaries, but they change not the beauty of the water--no more than the fleets of the world mark the waves of the ocean."

Only ninety-eight years, a relatively short time as far as history is concerned have passed since Mr Butler's succinct description and would to God that we could say the same things now that he said then. To our great shame and discredit, we cannot do so. We are told that Lake Erie is a "dead" lake, and that Lake Michigan is "sick" and that others have varying degrees of pollution. Lake Superior is presumably, at present, the cleanest of all of the five Great Lakes. This fact is not due to any great control on our part, more accurately can be attributed to more dense industrial activity on the four lakes lying to the east.

However, pollution is present and many cases have been recognized and others suspected. In addition others can be anticipated. A brief review of the situation follows:

1. St. Louis River Watershed--

It is a well-known fact that the St. Louis River is polluted. If there is any doubt, all one needs do is drive from Fond Du Lac to Carlton, through Fond Du Lac State Park, which parallels the river, and the smell should convince even the greatest skeptic. On May 22, 1958, the Duluth-Herald contained the following statement, "French River State Fish Hatchery crews are removing thousands of dead fish from the St. Louis River in New Duluth and Fond Du Lac." The Duluth Herald paper for August 22, 1968 contained the following partial statement: "Cloquet Mayor Walter Stock urged the Arrowhead Economic Development District, Inc., today to give a high priority to helping combat pollution in the St. Louis River." The river which flows into Lake Superior and has its source in east central St. Louis County, is 27% polluted even before passing through Cloquet. Stock said, additional pollutants are dumped in through city and industrial wastes at Cloquet. "The pollutents upstream from Cloquet, Stock said, are from natural sources such as swamps, lowlands and farms and also possible from other communities, such as Brookston, Meadowlands, Floodwood, and Forbes."

"We'll do Whatever we can to take care of our pollution," Stock said, "but it doesn't seem right that Cloquet should clean the river to 85% to 90% purity when it is already polluted to the extent of 27% before it gets to us." He acknowledged that the extent of pollution by the time the river reaches its mouth is such that if you take a boat up from Fond Du Lac it makes you shiver to see what's going on!

2. Duluth Superior Harbor--

The polluted water originating in the St. Louis River Watershed is joined in the Duluth-Superior Harbor by additional pollutants from the following sources:

a. Discharge of untreated wastes from ships using the Harbor.
b. Various industries discharging untreated, industrial and sanitary sewage from plants in Duluth and Superior directly into the Bay.
c. Insufficiently treated sewage from the cities of Duluth-Superior (as recently as three years ago the city of Superior was dumping raw sewage in the Lake.)

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3. Private Systems--
There is no secret about the fact that untreated effluent from private systems along the north shore of Lake Superior, and perhaps elsewhere, seeps into the Lake and also pollutes ground water sources.

4. Silt Problems--
It is easy for anyone to stand on the hills surrounding Lake Superior when the waves are battering the shores, and ovserve the brown layer of silt and other debris staining the clear waters. The effect is particularly great along the south shore of Lake Superior--this indicates the need for study and the institution of sound soil conservation practices.

5. Taconite Manufacturing--
At the present time, Reserve Mining Company is dumping about 60,000 tons of taconite tailings a day into Lake Superior. In passing, we feel compelled to mention that the United Northern Sportsmen Club stood almost alone in resisting the issuance of this disposal permit. Thus far we have seen no evidence to make us regret this resistance, and much evidence to make us feel we were right in resisting!

6. Other Areas--
We have confined our brief remarks to the Head of the Lakes. Certainly there are other areas along Lake Superior in Wisconsin, Michigan and Canada, which should be reviewed and evaluated.

7. Future Problems--
Recent newspaper stories have indicated the possibility of a Nuclear Breeder Plant being constructed along the north shore by the Union Carbide Company. As we understand the situation, the plant would be to manufacture Atomic Materials for other power plants--electric power would be a by-product. There were indications that 2 billion gallons of water per day, or 730 billion gallons a year, would be used and recycled. In 1966 the water appropriation from the Lake Superior Watershed (that is from Duluth to Pigeon River) was about 218 billion gallons per year of which 98.15% was surface water and 1.5% from ground water sources. It is obvious that the proposed plant would use more than three times the present water appropriation for the Lake Superior Watershed. We certainly feel that any such proposal should have a comprehensive advance study to provide the best answers possible to the following questions:

a. Why is the Knife River, one of the three finest trout streams on Lake Superior chosen as the site of this plant?

b. Effects on water quality--What changes in the lake itself, can we anticipate from all this warm water? How much and to what distance will the temperature of the Lake water be affected?

c. How many plants of this nature can the lake support?

d. Where should they be located so that it might be possible to utilize these B.T.U.'s for some industrial or other worthwhile heating purpose?

We have been speaking briefly of some things that are wrong, and some things that may be wrong, and we may have given the impression that we are unaware of the many organizations and individuals combating the problems. We are not! We have followed with interest and applause each forward step by the Federal Water Pollution Control Administration, and our own Minnesota Pollution Control Agency. We only wish it were possible for each to have unlimited resources, and to move faster. Also, we applauded the calling of the recent "Pollution Enforcement Conference in Chicago," but we were also a little saddened because the very name of the conference indicated that damage had already been done and that we were again starting the old familiar practice of "locking the barn door after the horse had escaped."

It seems to us that money-wise and other-wise we cannot wait until enforcement conferences are necessary. We can no longer accept the philosophy that the important thing is to bring in industry, at any cost, regardless of the consequences to water urity and other natural resources. It seems to us that one of the great problems in America today and a fallacy from beginning to end, is the belief that we can have good conservation practices without affecting the personal liberty or wallets of anyone, or without interferring with exploitation by industry. This was expressed clearly at a hearing by the Minnesota Pollution Control Agency at Duluth, Minnesota on February 23, 1968 (as reported in the Duluth News Tribune of February 24, 1968) when the Executive Vice President of the Northeastern Minnesota Development Association said--"He supported the control of water and air pollution--but--! not at the expense of losing jobs and penalizing future economic development! Water quality is not just a problem for the conservationist, the hunter, and the fisherman. Clean water is everyone's problem. It cannot be solved by one neighborhood, by one city, by one county, by one state, or by the Federal Government. If we are to use and, at the same time preserve our water resources we must have everyone's cooperative assistance. We believe that:

Everyone can do something about water pollution!
Everyone can help to clean up dirty water!
Everyone can help to keep clean water clear!

But, we do believe that many able assistants and protagonists for pure water and pure air are being lost through failure to inform them fully, and failure to provide a catalyst to unite the effort.

In paragraph three of this letter, we indicated that we needed your assistance, and perhaps now is the time to make our request known. We ask and we urge that you exercise authority,, which you now possess, and call at the earliest practicable date an interstate pollution prevention conference for Lake Superior, the Crown Jewel of the United States!

This could be an historic first, and clear evidence that we can act before our problems get out of control. It would be our thought that the conference should provide data in the following categories:

1. Put together all known facts regarding present pollution of Lake Superior and its various watersheds.

2. Put together data on steps now being taken to correct known situations.

3. Outline steps necessary to prevent pollution in the future.

Your cooperation and assistance in making this request become a reality will be sincerely appreciated!

Very truly yours,

Milton E. Pelletier
President-United Northern Sportsmen Club
3680 Munger Shaw Road
Duluth, Minnesota 55810

Mrs. Arlene Harvell

MR. BADALICH: Mr. Chairman, if the Minnesota recitation may continue, I would next like to call on the Save Lake Superior Association. I have a letter here from Mrs. Arlene Harvell, resident of Two Harbors, Minnesota.

STATEMENT OF MRS. ARLENE HARVELL, PRESIDENT, SAVE LAKE SUPERIOR ASSOCIATION

MRS. HARVELL: Members of this conference, ladies and gentlemen:

As President of the Tri-State organization known as Save Lake Superior Association, Inc., I will make my report in two parts. No. 1, I will present the position of our Tri-State organization and a representative sampling of the written testimony on which we base our position. No. 2, Dr. Louis G. Williams will present the scientific evidence that substantiates our statement.

The Save Lake Superior Association would like to preface our statement of position with three specific questions:

1. Are the intentions of this conference merely to justify additional appropriations or is it to seek the prevention of further pollution?

2. Gentlemen, we have been told over and over again to wait for all of the evidence. Should we, in fact, wait for all of the evidence? If I placed a drop of arsenic in my husband's

coffee every day and you watched me do it every day, would you wait for all of the evidence? Would you wait for a dead body before you took action? And are you now going to wait for the dead body of Lake Superior before you take action?

3. This conference has been told that there are taconite tailings in the Duluth, Minnesota, water supply, yet, through omission, they try to make us believe that somehow they are not in the Superior, Wisconsin, water supply. If this is true, then our Association would like to know where this invisible wall is located that somehow contains the waters of Minnesota and prevents their lapping over on the shores of Wisconsin and the shores of Michigan.

The Save Lake Superior Association is a response to the pleas of the residents who live around Lake Superior. We directly represent over 800 alarmed citizens of Minnesota, Wisconsin, and Michigan. It is our belief that any major pollutant dumped into the lake is carried throughout the lake and thereby constitutes interstate pollution.

It is the belief of our membership that the pollution of Lake Superior is a threat to the health and welfare of all the residents living around Lake Superior and, indeed, an indirect threat to the citizens of the United States of America. In fact, in the somewhat stronger words of the Honorary President of Save Lake Superior Association, Inc., Mr. Arthur Godfrey, "Unless something constructive is done along these lines very quickly, it is now a well-established fact that our beautiful little planet is doomed." We have this opportunity today to do something constructive.

We have witnessed the destruction of lakes and rivers through man's carelessness, foolishness, selfishness, permissiveness and greed. We know perfectly well that we are capable of destroying our own environment and thereby the lives of all who live within our environment. We also know that we are perfectly capable of exercising controls upon this environment. We have been told, in fact, by a representative here in District 61-A in Minnesota, Mr. James Euland, that it is up to the people to establish the priorities and that we are also free to change these priorities. Through this Association we hereby call for a change in these priorities.

We sincerely regret an abysmal lack of knowledge and thereby a horrendous error in allowing the establishment of a priority and a precedent in 1947 which allowed an industry to dump taconite tailings into the waters of Lake Superior. We wish to now have this error corrected, and, if it is necessary, to share in the blame and the cost that this correction might incur. We admit our past ignorance and plead with this conference to allow the correction as soon as it is humanly possible, that our children will not have to bear the burden of our wrong.

Mrs. Arlene Harvell

We ask that this conference carefully weigh the testimony of our many citizens who base their facts on good eyesight, on comprehension, and, indeed, on common sense, who may not be scientists, but who do claim to have their health and well-being at stake in this matter.

Many of our members are now or have been at one time commercial fishermen. It is a fact that the fish in Lake Superior will not stay in dirty water,that they are not to be found in commercial quantities in the grey water that is caused by taconite tailings. Our fishermen readily admit there are several factors which have contributed to the total decline in fishing. However, they point out the fact that studies conducted by various departments of the government have not indicated exactly where all the fish catches were made, only the area adjacent to the fisherman's docking facilities. Our fishermen will be glad to testify to the fact that commercial quantities of fish will not be found in the grey water area that is caused by taconite tailings. They wish also to call attention to the fact that their welfare has been directly affected by the continued discharge of taconite tailings into Lake Superior at Silver Bay, Minnesota. Many have, in fact, been forced to find other means of income. This is no longer a threat to them; it is an existing damage to their current welfare.

Mrs. Arlene Harvell

Many of our members own and operate tourist facilities. They testify to the fact that their business, and thereby their welfare, depends on the beauty of Lake Superior. It is their main tourist attraction and, indeed, for some their only tourist attraction. In fact, the local civic organziations, businesses, and industries appear to support the importance of the beauty of Lake Superior as they annually expend thousands of dollars to promote tourism and their promotional photos inevitably show beautiful scenes of Lake Superior. In fact, our Governor, Harold Levander, told a Senate Committee that a Federal-State commission charged with the economic revival of northern Minnesota, Wisconsin, and Michigan could profitably spend $1 billion to improve the region. However, the immediate plan involves $23 million for 1969-1970. The plan is to involve industrial development, tourist improvements, and projects for natural resources protection.

One of the major concerns of our membership is short-range plans for industrial development. It is our hope that no one industry will be allowed to use up, to degrade, or to pollute our greatest resource - Lake Superior. We wish to maintain the quality of our water in order to allow many industries to locate in this area in the future. We wish to be able to provide the water these will need for both industrial uses and for the increasing population of the area. The present degradation of

Lake Superior thereby strikes at the very heart of our economic development plans - at the plans for providing future sources of employment for the Lake Superior area.

Our members in the tourist industry depend upon a seasonal influx of tourists for their business, for their income. Our membership consists of many of these tourists who, in fact, are annual vistors to the North Shore of Lake Superior and of many who annually visit various attractions around the entire lake. These people are alarmed at the greyish band of water that appears in Lake Superior with increasing intensity. These people have visited many parts of the United States and have until now preferred the Lake Superior area because of its beauty and its "sky blue waters." In the interest of their health and welfare, that they may have an area conducive to rest and recreation, soothing to their hayfever, and in the interests of the welfare of the resort owners whom they support with their tourist dollars, we plead their case, and we will provide a sample of their written testimony.

The Save Lake Superior Association also represents many young adults. Psychologists and sociologists are continually finding links between our environment and our mental health. These young members of our society are alarmed at this threat to their environment. They listen to our good intentions and then they witness our actions or lack of actions in regard to pollution of their environment, the degradation of their legacy, and the fulfillment of our moral responsibilities. They bear witness to the pollution of their environment, to the threat to their future health and welfare, in fact, to the threat of their very existence.

We have many members who hold degrees in the various scientific fields. Several of these members express their witness to pollution in the letters which I will place before you soon. These people, perhaps above all others, realize the threat of continued pollution to Lake Superior. They bear witness to the turbidity of Lake Superior and the visible evidence that this turbidity is being caused by the Reserve Mining Company at Silver Bay, Minnesota. They feel that it is a crime against future generations to neglect the abatement of this obvious source of pollution.

The majority of our membership are property owners along the shores of Lake Superior and its tributary waters. These citizens, these already heavily burdened taxpayers, are alarmed at the prospect of having to pay for the cleaning up of these polluted waters. They have witnessed the mismanagement of water supplies in the East; they realize the inadequacy of present standards, and they look with horror at the ineffective enforcement of the present laws and provisions of permits. Is it any wonder that many of them have given up in despair and retreated into an apathetic state or that some are out demonstrating against our Government's policies. Will they have to pay the costs of cleanup plus the wages of those who allowed their errors to continue in the face of facts? These people have invested heavily in the future of our area and they have every right to expect at least a minimal protection of their investment.

It is through the personal testimony of our membership that the Save Lake Superior Association takes its present stand. We respectfully request the conferees to study a representative sampling of this testimony. I have those papers ready.

We summarize these points:

1. Taconite tailings in Lake Superior constitute interstate pollution.

2. The resulting pollution is a threat to the health and welfare of the residents of and the visitors to Lake Superior.

3. We request an adjustment of priorities and a correction of the existing situation. We are willing to share the blame and the cost of an alternative method of disposal for Reserve Mining Company's taconite tailings if this is a necessary procedure.

4. We ask for the immediate enforcement of the existing laws and provisions of the permits.

5. We plead for the protection of our environment and the health and welfare of our people.

6. We ask for a strong precedent to be set so that we may provide the leadership that this Nation expects from a Federal conference.

Mrs. Arlene Harvell

I have here a compilation of the Save Lake Superior, Association, "Analysis of the Economic Capability of Reserve to Control Taconite Pollutants." This has been examined by four qualified economists. We feel we should submit it to this conference. Is this acceptable?

MR. DOMINICK: Could I see your analysis, please?

MRS. HARVELL: Yes.

We also have two statements, one from our Michigan Chapter, who is relatively new and who is unable to provide a person to speak on their behalf today or tomorrow.

We also wish to submit what the young people have done on their own entirely.

And these (indicating) are signatures of the people who support our stand besides the many organizations who support our stand.

Then, to substantiate our position scientifically, we have the personal testimony of one of our members, Dr. Louis G. Williams. Dr. Williams has been doing research on problems of eutrophication since 1958, over a three-year period from 1965 through 1967. Dr. Williams worked specifically on the biota of Lake Superior. He was employed by the National Water Quality Laboratory here in Duluth. He was, in fact, the senior ranking member of the research team to September of 1967.

It is my honor and pleasure to introduce Dr. Williams.

MR. DOMINICK: Before Dr. Williams comes up --

MRS. HARVELL: He is here.

MR. DOMINICK: As to your analysis of the economic capability of Reserve Mining Company, you mentioned this had been compiled by four individuals, is that correct?

MRS. HARVELL: By an independent firm of economists, and it has been examined by four individuals.

MR. DOMINICK: Could you identify in the document where this came from and the four individuals who examined it, and we would be happy to place it in the record.

MRS. HARVELL: I do not have a statement available from these persons. They are members of our Association. It is the policy of our Association not to reveal the identity of its membership unless we have a written statement doing so, because of the fact that many of our members work for pollutant industries and their jobs may be threatened, therefore!

MR. DOMINICK: Would you identify the firm?

MRS. HARVELL: I will identify one of the individuals who, I believe, has given his permission, who is an economics teacher at the University of Minnesota, Duluth, Mr. Nelson.

MR. DOMINICK: Very well, we will have this as an exhibit.

(The above-mentioned analysis is on file at Headquarters, FWPCA, and the Regional Office, Chicago, Illinois.)

Mrs. Arlene Harvell

MR. DOMINICK: We will also receive your list of signatures. How many signatures are on this, do you know?

MRS. HARVELL: I have not counted them. The children did those.

MR. DOMINICK: We will be happy to place in the record the Michigan statement and receive as exhibits the material that you presented to the conferees.

(The above-mentioned signature lists and other material presented to the conferees, are on file at FWPCA Headquarters, Washington, D. C., and the Regional Office, Chicago, Illinois. The above-mentioned Michigan statement follows.)

SAVE LAKE SUPERIOR

The majority of the residents of the Northern Counties of Michigan when asked about the condition of Lake Superior will say, "It's clean now, not as clean as it was 10-15 years ago, but not to the point where it can be called polluted." Right down the line they agree that something should be done to insure a fresh water Lake for years to come but lack a concrete plan for cleaning it up. This plan, whatever it may be, must include the necessary provisions stopping the current causes for the Lake getting "dirty".

The legislation ultimately passed will be worded by representatives in our State Legislatures, and in Washington D.C. by our Congressmen. These men, no matter how well intentioned, must listen to the voice of the people who are most familiar with the Lake and how it is being used and abused. Scientists agree that the Lake is far from being its original self. The degree of deterioration can be argued, but all scientists will agree that it is aging faster than it should be.

It would be a sin for no action to be taken now as any delay would hasten the day when large expenditures of funds would be needed to undo the harm being done. This experience can be noted in the lower Lakes of Erie, Huron, and Michigan.

We, the concerned citizens of Michigan present to you the following letters from the people who know Lake Superior the best, the lake shore residents.

President, Michigan Chapter of
the Save Lake Superior Association

Subscribed and sworn to before me this
14th day of May 1969

MELVIN W. LUOMA
NOTARY PUBLIC GOGEBIC COUNTY, MICH.
[illegible] 30, 197[illegible]

MR. BADALICH: Will the conferees be furnished a copy of the economic study, Mr. Chairman?

MR. DOMINICK: We have taken this as an exhibit. We will try to have copies made of it and furnish it to the conferees.

STATEMENT OF LOUIS G. WILLIAMS,
SAVE LAKE SUPERIOR ASSOCIATION
(Univ. of Alabama)

DR. WILLIAMS: Mr. Chairman:

At the present time Lake Superior is not a pollution crisis; neither was Lake Erie two generation gaps ago. Lake Superior, however, has lost its virginity chiefly to a small segment of the mining industrial complex, which disposes of 60,000 long tons of taconite wastes per day into this largest freshwater supply in the United State of good water quality.

We cannot blame the economics. They are lawfully operating with a permit, which was based on "legal" hearings. The original permit to discharge these finely pulverized taconite wastes and several revalidations of this permit have been made, all based on tests and especially public hearing. Each time the judgments have been that the lake has not been adversely affected, based on standards in which they legally operate.

Recent findings, however, using more sensitive scientific instruments and new methods, may mean that the Reserve Mining operations are badly in need of a fresh assessment.

Louis G. Williams

Like Lake Tahoe between California and Nevada, Lake Superior is still one of the cleanest and clearest freshwater assests in the world. This is true because other large lakes have become man-polluted. Lake Superior is an irreplacable scenic treasure and natural resource. To protect it from destruction by taconite pollution causing accelerated eutrophication, present judgments should be based on recent test finding, using newly developed scientific methods and the more sensitive equipment which were not available when Reserve began its operation.

At the present time the waters of Lake Superior are not enriched when compared with other major bodies of water, and they support a phytoplankton population about the same biomass density as Lake Tahoe.

By present enrichment criteria these beautiful lakes are not polluted. Yet, the interests for preserving Lake Tahoe has been so great that wastewaters that used to empty into Lake Tahoe are now being diverted away for irrigation in Nevada. Tahoe's principal threat has been enrichment from phosphorus and nitrogen. While nitrogen and phosphorus are minor problems for Lake Superior, the major pollution threat to the purity of Lake Superior are from metabolic trace metals in circulating taconite from the Reserve Mining tailings. These trace metals, on reaching threshold concentrations, bring about enrichment and blooms of unwanted bluegreen algae, and the constantly shifting taconite sand is spreading with water turbulence to cover and smother beneficial crevices in rocks which serve as niches for many beneficial lake organisms. Breeding places are destroyed, and some of the trace metals have reached concentrations that drive away beneficial sport fishes.

These findings are not based on feelings but on many years of study and specialization, including the examination of raw water samples from Lake Superior from 1958 to September 1967 while I was in charge of the aquatic biology program, chiefly plankton, of the US PHS National Water Quality Network of 128 stations, which included the Great Lakes. From 1965 to 1967 I was transferred to Duluth, where I was in charge of the plankton program of the National Water Quality Laboratory. Space will not permit here a report on the extensive research I conducted on many aspects of water quality of Lake Superior based on the factors of the lake that affect the plankton and periphyton populations and their reactions to the circulating taconite tailings from the lake.

The first priority of any discussion of the water quality of Lake Superior should be an attempt to inform the citizens about the general principles of limnology and eutrophication so as informed people they may exercise responsible judgments. Much speculation exists as to the fate of Lake Superior. Will it become another Lake Erie? Extensive public hearings are not necessarily the solution, because the validity of much of the testimony has already proven to be incorrect in past hearings. For example, in a hearing on August 24, 25, and 26, 1966, W. K. Montague testified, "...taconite consists essentially of hard rock which is crushed down and from which the iron ore particles are removed by magnetic separation. The remainder is nothing but coarse and fine sand. It is like the sand which the North Shore streams have been pouring into Lake Superior for three thousand years. There are no chemicals added."

Now, we know as a matter of scientific fact that the sands are chemically unlike those of the North Shore streams. Turbid particles from these streams vary from yellow to red to brown, but the taconite particles are gray. We know that both fly ash and CaCl have been added to the waste discharge. We have been repeatedly told that these taconite tailings wastes are harmless and inert. Today we know that some of the chemicals in taconite wastes are highly metabolic, and that they significantly add to the aging process of Lake Superior, which tend to make it more and more like "old" Lake Erie.

Perhaps the biggest misjudgment has been the belief that high density currents would carry the taconite wastes to a deep trough and that the lake would remain in its state of purity, because none would get out of this relatively small dump.

MR. DOMINICK: Mr. Williams, could you suspend for just a moment.

Louis G. Williams

I note here that your statement runs to seven pages single spaced. Would it be possible to summarise this statement in any way? We have the statement before us and it will be included in the record in its entirety.

DR. WILLIAMS: I believe the Save Lake Superior Association has gone to a great deal of trouble to bring me here. I have taken off from my classes at the University of Alabama, made a lot of effort to get here myself.

MR. DOMINICK: I appreciate that.

DR. WILLIAMS: I am probably farther away than any one of this conference. I believe my statement is worthwhile and the audience should hear it.

MR. DOMINICK: Very well, you may proceed.

DR. WILLIAMS: From numerous samples taken along both the North and South Shores I have repeatedly found fine, gray taconite sands being widely spread during periods of water turbulence. Filling up the rock crevices destroys niches for the good guys, which are some of the food-chain organisms to fish. The water quality has been markedly deteriorating based on more and more green algae, and especially nuisance bluegreen algae, instead of domination of diatoms, of the clean water community types. This taconite sand deposition was further studied by placing special large glass substrates at selected sites on the bottom below the wave lash zone.

Louis G. Williams

I have found that the dispersed particles in the waters of the North Shore streams draining into Lake Superior are unlike those of the taconite particles and that the silt contribution from these North Shore rivers are negligible when compared with the 60,000 long tons per day of taconite wastes and especially the tiny sizes (0.5 to 3.0u) that circulate wherever water flows in and from Lake Superior

There are numerous statements about the "green illusion water." One can now say that there is no longer any illusion about these green waters. They are real color from taconite particles and from algal blooms produced by their enrichment. I have been able to produce these algal blooms in the labroatory by adding taconite colloids to lake water. The green water in the lake, I have observed repeatedly, is a result of surface flowing water, usually driven by wind, blowing toward or away from the shore and causing the deeper strata of water to upwell and bring the settled taconite particles back into resuspension. This phenomenon is associated with warm surface water. These tiny silt particles are carried for many miles by the lake currents.

The very fine particles (colloids) which were obtained by alum flocculation of water after passing through a membrane filter circulate in surface water all over Lake Superior and downstream to other lakes and into the St. Lawrence River and on to the Atlantic Ocean.

These colloids are particularly important in Lake Superior for a number of biological reasons dealing with acceleration of eutrophication. Without these circulating suspended particles of taconite, some of the trace metals (copper, zinc, molybdenum) would be in too short supply to support the present corps of phototrophs of both the phytoplankton and the periphyton. During the warm-water period in late summer and early fall, blooms of bluegreen algae and some green algae occur in populations as high as 130,000 cells per milliliter, which is an extremely bad indication of short-term eutrophication associated with taconite suspended particles.

Most biologists know that some bluegreen algae are able to take nitrogen from the air, dissolved in the water, and fix it to a usable nitrite and nitrate only when the trace element molybdenum is present. Colloids of taconite were found to have a relatively high content of this tract metal, which might explain the enormous blooms of nuisance bluegreen algae.

This report of necessity must be an oversimplification, because the humans charged with decision-making concerning the life and death of Lake Superior must rely on outside professional help. Here there is often a communications gap. They must realize that the most important organisms in the lake from both a nuisance viewpoint and a food-chain to sports fishes are the phytoplankton which are followed by the zooplankton and through many kinds of tiny microinvertebrates. To communicate to the public about the welfare of these tiny microbes is most difficult. I see them and know them and I know their positive and negative relationships to the welfare of the entire lake ecosystem. On the other hand, I must either deal with fishes, which are not microscopic, or first try to explain the vast biomasses of the tiny, unseen plankton. My studies have been chiefly at the base of the food chains to fish. However, biologists, who work principally with fishes, are better able to reach a fish-conscious audience.

From 1958 to 1967 I studied the kinds and numbers of planktonic organisms in the major waterways of the United States, while I was in charge of the program for the US PHS, (which later became the Department of the Interior) being stationed in Cincinnati until my function was transferred to Duluth.

Communities of these unseen (microscopic) organisms do have personalities and by their diversities do reflect, like a modern computer, the quality of the water in a manner far more sensitively than any known present chemical method.

These organisms are now telling us that Lake Superior has taken a turn for the worse. It has the germs of an infection from taconite wastes. Some damage has already been done. As people (who pollute) we can still arrest this disease now by stopping the flow of taconite metabolic trace elements to Lake Superior.

Louis G. Williams

Taconite pollution of Lake Superior is to a large extent the addition of particulate matter to the lake. Researchers whose specialty is culturing these microbes have demonstrated that these microbes must have certain chemicals to live. An over-supply, however, of some kinds of chemicals produce unwanted (eutrophic) conditions. The traveling varieties of taconite particles in the Great Lakes have been tested and found to be associated with the unwanted high productivity in the lakes, probably because of the concentration and adsorption of nutrients for centers of biological activity. These result in unwanted bluegreen algae. The unwanted bluegreens are unwanted because they are poor food-chain organisms and produce poor conditions for growth of wanted food-chain organisms. Space here does not permit elaboration on the many cultures and bioassay studies that I conducted in the National Water Quality Laboratory at Duluth that supports this position. I have always treated my data as preliminary. Lake Superior raw water was brought into the laboratory in large quantities for these studies, as my fellow workers at the Duluth National Water Quality Laboratory will attest.

Lake Superior raw water was brought into the laboratory, then in the Old Main Hall of the University of Minnesota at Duluth, where it was used by culturing technique for various ways of assessing the enrichment (eutrophication) of various places at different seasons for the influence of taconite suspended particles.

Louis G. Williams

The suspended material was filtered, settled, centrifuged, and flocculated. Within the range of oil emersion microscopic examination of 1,000 times magnification with special hyrax slides the particles were sized. Toxicity was evident from tailings taken from the vicinity of Silver Bay, based on laboratory bioassay technique to species of Daphnia and Diaptomus. These particles impart something to the water that hurt diatom communities and promote nuisance populations of bluegreen algae, which are undesirable for food-chain organisms to fish.

There is some gratification to me that the 404 page report by the Great Lakes Region of the Federal Water Pollution Control Administration concerning the water quality of Lake Superior in the vicinity of Silver Bay, Minnesota (December 1968) fully supports my work, which had been reported prior to September 1967. Likewise, much of the work of the recent survey of the Duluth National Water Quality Laboratory also essentially substantiates my reported findings.

"Doing one's thing" these days appears to be the way to success. Some professionals on college campuses have become highly successful in bringing before the public a need for a change of some of our faulty public policies. Through disruptive practices, however, a few minority groups have been able to accomplish changes that are not in the long-term welfare of the majority. Being humans, we cannot divorce the issue of taconite pollution from the positive economic considerations, such as jobs and profits. Therefore, we are dealing essentially with problems that have many components. Some of these are selfish.

Louis G. Williams

After removal of the selfish aspects the remaining problems are still very complex, because they deal with principles of aquatic ecology, economics, and sociology. Any worthwhile hearing or conference on the state of health of the big lake must permit a common meeting ground for not only responsible ecologists, conservationists, economists, and sociologists, but also responsible representatives of the mass news media. All of the people of the United States own the lake and have a big stake and pride in its natural resources. Furthermore, moral issues are involved. We must address ourselves to the question: What kind of a Lake Superior do we want to pass on to future generations?

I do have clear-cut answers to some of the scientific questions about the ecologic state of Lake Superior in respect to taconite contamination. I cannot, however, represent ethical moral, economic, nor social issues. The records over the past 10 years clearly indicate that the process of having public hearings and attempting to decide scientific solutions by this method have failed miserably. Apparently past "scientific" testimony is now obviously faulty, since some of it has since proven to be untrue concerning the fate of these wastes in the lake. This has a parallel in the solution to the racial tensions. We cannot solve the racial issues by having a white biracial committee and a black biracial committee. Can we have our cake and eat it, too? In the first place, we must decide between a clean Lake Superior, or the economic benefits of making Lake Superior a dump. That is our choice.

Louis G. Williams

Considerable scientific data is presently available to give answers to questions about effects of taconite wastes on water quality, fish-food organisms, commercial and sport fishes, recreational and aesthetic values.

From my intensive studies of 128 water sampling stations of the major waterways of the United States, including the Great Lakes, I have been able to assess rather reliably the ecologic state of many sampling stations and to predict their fates when abatement practices went unheeded. Being a researcher, I have never been in a policy-making capacity while working for the Federal Government. But at times I have been denied the opportunity to present expert testimony to policy-making bodies as well as to my own colleagues, and I am real proud to get to this hearing today.

After I left the National Water Quality Laboratory a policy was apparently instituted to downgrade my work while I was a researcher there. This is based on letters and statements from people still in high positions there. I am gratified, however, that the recent studies of several Federal agencies have validated my reported findings, and these have been published.

Should history repeat, my testimony at this hearing will likewise go unheeded. This is somewhat similar to telling a person of his probabilities of contracting cancer from excessive smoking, or becoming a chronic alcoholic from too much social drinking, or to drug addiction from "small" trips.

Louis G. Williams

Considerations at this hearing which are most likely to carry the most influence are going to be jobs and profit issues. The effect of the exploitation of Lake Superior as a dumping site may have to wait until it is considerably more like Lake Erie, whose eutrophication is now irreversible. To offset this bread and butter issue, we must show that a clean lake brings in a lot of tourist dollars, which could be here for many years for long-term investment.

Perhaps I am over-critical concerning many Minnesota newspapers and TV stations that seem to have been guilty of giving preferential treatment to glowing statements about how the Reserve Mining Company is looking after the welfare of Lake Superior. For example, a front page article of the Duluth News-Tribune of Saturday, September 16, 1967, attributed to a "spokesman" from the Reserve Mining Company is now known to be untrue. Here below each item will be serially numbered for later comment by referring back to its number."

(1) Charges that dumping of taconite wastes in Lake Superior threatens water quality and the Apostle Islands National Lakeshore Program in Wisconsin are without foundation and apparently the result of a misunderstanding.

(2) Schmid said,"We haven't injured the lake in any way and no one is more careful of Lake Superior than we are.

(3) Turbidity of the lake has not increased during the last 12 years.

Louis G. Williams

(4) All we are putting into Lake Superior is sand like the streams on the North and South Shores have been doing for thousands of years.

(5) The sand is deposited on the beach and the colloidal fine materials are going into the deep trough (700 to 900 feet) just as the studies indicated that they would.

(6) Our tailings are comparable to these other sources of sand but contain no organic materials nor chemicals that would be dissolved in the water.

(7) We are confident that future careful study of our use of Lake Superior will show what so many scientific studies of the past have shown - that Reserve has not injured Lake Superior of any of the beneficial uses of the lake. (Unquote.)

The Duluth Sunday News-Tribune, January 19, 1969, carried a front-page article written from St. Paul by Karlstrant, which said in part:

(8) "State Senator Raymond Higgins, Duluth, said Saturday he may ask for an investigation by the Minnesota Legislature into what he termed 'unfounded allegations' that Lake Superior is being polluted by taconite tailings discharged at Silver Bay by Reserve Mining Company."

Louis G. Williams

(9) Higgins, in whose district the Reserve plant is located, asserted that Minnesota is entitled to know the true facts and leveled scathing criticism...for unjust and perhaps erroneous accusations of one of the State's finest corporate citizens.

(10) These moves are being activated by certain preservation groups.

(11) John Badalich, Executive Director of the Minnesota Pollution Control Agency, said Minnesota will cooperate in the Duluth Conference, but will hold its own hearings.

The St. Paul Pioneer Press carried an editorial which was also printed in the Duluth News-Tribune, Friday, January 12, 1968, which said in part:

(12) "It is no secret that 60,000 tons of crushed rock are dumped into the lake at Silver Bay...the point is, however, at this time there is no official evidence stating that this is the cause" etc.

(13) So on with the study, and for the moment critics should stop screaming wolf. Maybe there's one out there. But let's see it.

(14) Dr. Mount, Director of the National Water Quality Laboratory, said, "we haven't gotten deeply involved in the subject yet."

Now let's look at what the people of Minnesota are reading in their newspapers. Many of the above-numbered items are either untrue or irresponsible. In Item 14 above, Dr. Mount should have known that I did become perhaps too deeply involved in the taconite pollution research, but I worked under Dr. C. M. Tarzwell, then Director, before Dr. Don Mount came aboard as Director. I am quite sure that Dr. Tarzwell knows very well of my findings from my frequent reports to him and from actual on-the-spot examination of the experiments conducted in the laboratory, then in Old Main Hall of the University of Minnesota-Duluth. Why didn't Dr. Mount seek from Dr. Tarzwell my reports? It is true that Dr. Tarzwell had earlier told me to direct my research away from taconite studies, but he later returned to Duluth and told me to go back to full strength research on this problem of taconite contamination on the biota of Lake Superior. I must say that no one can do any kind of research on the biota of Lake Superior without involving taconite, inasmuch as it is a principal factor in most any project one would undertake if it gets to the meat of the lake's biota.

Now let's take each item above by corresponding number. Item (1) is untrue, because I found taconite silt deposited along the bottom in protected places of the Apostle Islands, and these deposits are still there for further study. Therefore, the use of "without foundation" and "misunderstanding" are misleading, to say the least. Further, highly metabolic colloids are being dispersed not only through the Apostle Islands, but throughout Lake Superior and its waters draining toward the Atlantic Ocean. These studies are based on modern techniques using membrane filtration, centrifugation, alum coagulation, and high power observation under a microscope using 1,000 times magnification.

Louis G. Williams

Item (2) by Schmid that they have not injured Lake Superior is simply untrue for several factors. First, let's discuss copper-zinc solutions. J. B. Sprague in August 1964 published an article in the Journal of the Water Pollution Control Federation on the avoidance of copper-zinc solutions by young salmon in the laboratory. He showed that the adult Atlantic salmon avoided sublethal copper-zinc pollution in an eastern Canadian river. Copper content of the laboratory water was 2 µg/l, and zinc was 3 µg/l. Now, in my research at Duluth I found average summer and fall concentrations of copper and zinc to be respectively 6.8 and 7.2 µg/l in the lake water taconite colloids collected just east of the city. This was the residue on a .45 membrane filter. The filtrate, which passed through the filter, had respectively 1.0 and 3.7 µg/l. These results were published along with other information in BioScience, Volume 18(1), Pages 36 and 37, in 1968. Here is prime evidence that copper and zinc from circulating taconite wastes do have bad effects. Here they would have an effect of driving away desirable sport fishes. Furthermore, Sprague and Ramsey, in J. Fish. Res. Board of Canada, 22(2)425-432, 1965, have shown that these two trace metals found together account for a type of potentiation for the death of salmon that is more than additive. Concentrations of these metals in several times higher in the delta area of the Reserve Mining tailings. When not killed by these metals, some planktonic organisms concentrate them many times than found in the surrounding water and pass them along the food chain to fish.

Louis G. Williams

Also, I found molybdenum in later summer and fall to be respectively 3.8 and 2.5 µg/l associated with the circulating taconite particles, and after filtration through a .45 u membrane filter. Molybdenum is a very dangerous stimulant to some bluegreen algae, because molybdenum enables them to fix nitrogen and thereby increase the eutrophication of Lake Superior. During the late summer and fall large populations of bluegreens were found in the raw water intake of the water treatment plant of Duluth.

In shallow bays between Duluth and Two Harbors, I have found white fungus slime covering periphyton on rocks, strongly indicating severe toxic conditions for the biota there.

Item (3), turbidities from taconite particles are on the increase, which has not only been documented by my studies, but also by those of the Federal Water Pollution Control Administration Chicago study.

Item (4), careful studies by me reported in BioScience, 18(1):36-37, 1968, and the Federal Water Pollution Control Administration demonstrate that Reserve Mining is putting into the lake highly metabolic substances.

Item (5), much of the taconite, the most dangerous portion, is not going into the trough as early studies indicated it would. Instead, it is circulating as buoyant, dispersed fine particles wherever water moves in and from Lake Superior. Attached to these particles, adsorbed to them, are highly eutrophic substances, such as zinc, copper, and molybdenum, which came from the taconite tailings. Additionally, there are nitrates and phosphates picked up from river discharges, such as the St. Louis River, which are increasing the fertility of the lake to nuisance blooms of bluegreen algae.

Item (6), my studies of several North Shore streams and those of the Federal Water Pollution Control Administration recent survey show that the "sands" from taconite are spectacularly different from those of the rivers along the North Shore. I made numerous special hyrax microslides and for study of these fine particles under the 1,000 magnifications of my research microscope while in Duluth. I am sure that all of the then personnel know about this research.

Item (7), this is obviously not true, because of the widespread and smothering effect of taconite silt in the breeding niches of many beneficial organisms. This is a form of physical or displacement pollution. In addition to this displacement pollution, these silt particles carry with them undesirable metabolic trace elements, which are always associated with the circulating colloids.

Item (8), Senator Higgins is now obviously in error in his use of "unfounded" and "allegations" in reference to known taconite pollution.

Item (9), I agree with Senator Higgins, and I hope that others will join us, that Minnesota is entitled to know the "true facts."

Louis G. Williams

Item (10), these moves are being activated by certain preservation groups ... he is again so correct. One of these groups is the North Shore centered Save Lake Superior Association. What can possibly be wrong with having responsible citizens organized into any kind of groups to help save this great national resource. I now hope that the Senator will join us. If not, I hope he will turn his efforts to improving the resources of the lake for all beneficial uses.

Item (11), this would tend to make any thinking person, after reading this newspaper account by Mr. Badalich, believe that the Duluth Conference and the Minnesota Pollution Control Agency do not hold the same kind of conferences. If all parties are completely objective, there can be no need for separate hearings and conferences. Mr. John P. Badalich is Executive Secretary and Chief Executive Officer of the Duluth Chamber of Commerce. Now, I hope he has some real basis for promoting all of the beneficial aspects of the big lake. Based on a statement by Richard Schoon, Manager of the Duluth Chamber of Commerce, that the organization "supports water quality improvement of Lake Superior and its harbor areas wherever the need for such programs are adequately supported by fact, where the public agencies authorized to administer such programs come up with reasonable time schedules for their implementation."

Isn't the present state of the "facts" now adequate for Schoon and Badalich to begin a change of policy of immediately" stopping the enormous detrimental influence of taconite wastes on the water quality of Lake Superior? Who must decide reasonable time schedule? What are "facts" to the Chamber of Commerce?

Surely, now, Mr. J. Eric Jones, Executive Vice-President of the Northeastern Minnesota Development Association, will support the much-needed change. He has stated the policy of NEMDA when he said, "We must not have development with pollution." In 1967 Reserve's direct payroll was about $26 million. Jones says that industry creates jobs. He is on record (Duluth News-Tribune, Saturday, February 24, 1968) where he is reporting his position: "... Jones said he supported the control of water and air pollution but not at the expense of losing jobs and penalizing future economic development."

Certainly there are now enough solid facts to convince business that the many resources of Lake Superior must be now developed, because future development will be too late.

Is Mr. Schoon insinuating something when he says, "... public agencies authorized to administer such programs come up with reasonable time schedules for their implementation." Surely Mr. Schoon cannot be so naive as to believe that "public agencies" cannot sin. The simple fact is that the so-called "public agencies" support such organizations as NEMDA and the Chamber of Commerce. When these organizations realize the full impact of Lake Superior pollution and proper abatement the "public agencies" will respond accordingly.

Louis G. Williams

Item (12), what is official evidence and what is scientific evidence? Between these two, which is the more valid? Mistakes have been made and will continue to be made when the "official" evidence is contrary to the scientific evidence. Scientific laws have never been based on "official evidence."

Item (13), I agree. Let's do talk about the circulating taconite dispersed particles and their detrimental metabolic effects.

Item (14), Dr. Don Mount, now the Director of the National Water Quality Laboratory in Duluth, should know that I did become deeply involved in taconite controversy. In his official position he must reflect policy of his Federal agency for his success. I'm quite sure that Don Mount and I are basically the same on our ideas about the water quality of Lake Superior. Because of his background as a fishery biologist, however, he would tend to interpret conditions in terms of fish. The major problems of Lake Superior deal mostly with the phytoplankton, and this is my specialty. People know fish but most of them do not know the plankton. So I have a major communications gap to the average layman who is deciding what are the real implications of the role of plankton in the eutrophication of Lake Superior. I do sincerely hope that my research findings about Lake Superior can now take seed. Also, I trust that I will not be ostracized, as I have been in past situations, for stepping out of my role in research to bridge the communications gap between the lay public and science.

Louis G. Williams

General Conclusions.

Beautiful, clean lakes and people-pollution (too many consumer-produced wastes) are incompatible. Clean lakes remain beautiful and serve many benefits only by thoughtful management practices. Before the event of industrialized man clean lakes were gifts of nature for long periods of time. The industrial (including farming) and domestic enrichment of waters have played havoc with the other Great Lakes bringing about excesses of phytoplankton and other algae that have destroyed recreational and other beneficial uses of lake water.

Since the other lakes are rapidly going or gone, Lake Superior could satisfy a big national demand for clean, nuisance-free water. This demand will increase with more and more leisure time and the ever-growing population pressure. I am almost sure that any intelligent appraisal would place uses of Lake Superior, other than for the disposal of taconite and other wastes, of far greater economic importance than the advantages to be gained by continuing to allow the Reserve Mining Company to pollute the lake. For great savings to the economy of the North Shore and all of the shores of this big lake, the Reserve Mining Company can continue to operate by putting its taconite wastes in some of the big holes that have been formed from previous ore mining operations. Other ore mining companies are now doing this. Reserve has made many years of profit by using the lake as a "cheap" dump for its wastes. Certainly, speed must be now exercised to stop this wholesale destruction of Lake Superior.

Louis G. Williams

Preserving Lake Superior is now a national concern. Greater education of the public of the real issues at stake is sorely needed to control this great national resource for the maximum use of all of the people. With this kind of understanding I hope that Reserve will want to serve the hopes of all of the people. This is not to imply that the Reserve Mining Company has not had this attitude all of the time. Now we know that the basis on which Reserve was given a permit to discharge its wastes to the lake was grossly in error.

Now, what is the first order of change for the better? The media for the mass communication can be of great service to the people not only of Minnesota but the entire world, by attempting to communicate the complexities of interpreting and managing the role of phytoplankton and other biologic problems associated with preserving the beneficial qualities of our big, clean, fresh water, inland sea.

My involvement in the taconite waste enrichment is simply to focus a considered attention to those factors that stimulate aging by nuisance growth of plankton (eutrophication) which have already played havoc in the other Great Lakes. Help from the mass media is necessary to support the prediction that by continuing to increase the rate of growth of nuisance bluegreen algae from taconite wastes Lake Superior will go the way of Lake Erie. Now, does this position take me out of the role of a research scientist and into the role of a "self-interest politician?"

Louis G. Williams

Lake Superior is unquestionably one of the most interesting and beautiful lakes in the world, yet until recently it has received surprisingly little attention from aquatic scientists who are interested in preserving its oligotrophy, which is the opposite of eutrophy. Surely scientists of the Reserve Mining Company - one of the State's "finest" corporate citizens - will in the light of the new facts expedite its effort to preserve this great national resource for the benefit of all of its present and future citizens to enjoy and to make even more big economic returns.

Thank you for your kind attention.

(Applause.)

MR. DOMINICK: Thank you, Dr. Williams.

I would like to make one short statement with respect to Dr. Tarzwell. He is internationally recognized in the field of aquatic biology, and is, perhaps, one of the finest scientists in the entire water quality field. I am sure that none of your remarks by implication or otherwise were intended to impugn the scientific credibility or responsibility or professional ethics of Dr. Tarzwell.

DR. WILLIAMS: May I make another statement.

I am sure this is not true. I do not know who told Dr. Tarzwell to have me quit working on the taconite material.

MR. BADALICH: Mrs. Harvell, is this the final testimony for you?

MRS. HARVELL: Yes.

Dale W. Olsen

MR. BADALICH: Next, I will call on the Duluth Chapter of the Izaak Walton League.

Is there a representative here?

MR. MERRITT: Are we going to take a break for dinner?

MR. DOMINICK: How long will your statement be, sir?

MR. OLSEN: Fifteen minutes.

STATEMENT OF DALE W. OLSEN,
REPRESENTATIVE, IZAAK WALTON
LEAGUE OF AMERICA, DULUTH CHAPTER
DULUTH, MINNESOTA

MR. OLSEN: My name is Dale Olsen. I trust this will be as brief as possible. I emphasize the fact that I represent our Duluth Chapter of the Izaak Walton League of America, and we are presenting essentially the non-scientific viewpoints as concerned citizens who live in this area.

As lay citizens of the Lake Superior Basin concerned with the present and future quality of this great natural resource, we wish to include the following statement as part of the hearing record of this conference:

Dale W. Olsen

We preface those remarks with reference to a work by one of Minnesota's finest conservationists, Richard J. Dorer, which reads as follows:

"That great eternal and creative Force
Which set the sun and moon upon their course,
Splashed heaven's canopy with stars, and made
The seasons pass in endless cavalcade,
Gave man dominion of the Earth and all
The living things that creep and crawl,
That walk and swim and wing the vaulted sky
Or stand and serve -- immobile -- such as I.
Be not a blinded, self-destructive fool
Who challenges relentless Nature's rule.
If she offended be -- for each offense --
She will exact the fullest recompense." [1]

We feel that no more succinct and eloquent statement of our concern for man's lack of stewardship of his environment and its precious resources and particularly the problems of pollution and contamination is to be found.

The position of the Izaak Walton League on matters of environmental pollution is well known to most citizens of this Nation. We have consistently supported and, indeed, helped initiate practices which recognized the individual's right to quality of living as expressed by the absence of environmental pollution.

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1. Richard J. Dorer, "Relentless Nature," The Ghost Tree Speaks. Minneapolis: Ross and Haines, Inc., 1964, p. 71.

Dale W. Olsen

The Izaak Walton League has not confined its studies and actions to matters of particular interest to the sportsman alone, but rather to the broad spectrum of issues which relate to the conservation of all resources. This is especially true of League activities in recent years. Our concern for Lake Superior, therefore, is simply a logical extension of that interest in conservation which has characterized the philosophy and activities of the League since its inception.

We have learned through scientific reports and from the public press of the rapid deterioration taking place in the four lower Great Lakes. Scientists speak of a natural aging process called eutrophication, pointing out that all lakes are subject to this phenomenon and that the rate at which it proceeds varies with many natural factors at work in the lake itself and in the surrounding drainage area. Inasmuch as the Great Lakes are comparatively young, the natural aging process should not be a matter of great concern because the rate of change is slow, even by the geological time scale. Recent studies show, however, that the aging of these lakes is now being accelerated tremendously by man's disregard for the long term effects of his actions. Population in the Great Lakes Basin has increased from a few thousand in the 1870's to more than 30 million in the decade of the 1960's. Industrial and municipal wastes have been pouring into the lower lakes at rates unforeseen even 10 years ago, with the resultant negative impact on the water quality of these great natural reservoirs. Indeed, the effect in the case of Lake Erie may soon be irreparable.

Dale W. Olsen

Only Lake Superior has been spared the serious deterioration now common to the other four lakes. Members of the Duluth Chapter, Izaak Walton League, in common with many other citizens of the Lake Superior Basin, now ask the question, "Will we heed the tragic experience of the lower lakes and take measures now to assure future generations a lake which is free of those undesirable elements which may eventually lead to irreversible processes of deterioration?"

We believe that present techniques of environmental pollution control, properly established and administered, can provide the guarantee of a clean lake for as long as man desires. The Izaak Walton League is not opposed to industrial growth in the Lake Superior Basin provided such expansion is in harmony with long-range goals for the maintenance of quality in the natural resources of this region. Therefore, it is in the light of recent experience in the lower lakes, the body of scientific knowledge which clearly points to the hazards of unchecked pollution, and the Duluth Chapter, Izaak Walton League's record of active support for the conservation of natural resources that we cite the following areas of concern as they apply to the Lake Superior region:

1. Nuclear plants. We have serious reservations about tentative plans of the Atomic Energy Commission and Union Carbide Company to construct a gaseous diffusion atomic installation along the North Shore of Lake Superior in the vicinity of Knife River.

Dale W. Olsen

We share the concern of many in the Lake Superior Basin who fear the possibility of thermal and radioactive pollution which might accompany the construction of such a facility. We also fear destruction of one of the Nation's finest steel head fisheries as a consequence of such activity. The effect of discharges from such a plant on present and projected research programs at the National Water Quality Laboratory in Duluth also raises grave questions concerning location of a gaseous diffusion atomic plant in such close proximity to the basic freshwater research program at the laboratory.

A much larger question, however, has not been asked, and this question relates to the priorities society wishes to establish for the utilization of lands adjacent to the shores of Lake Superior. We have grave misgivings about the wisdom of committing unspoiled lands and waters to functions which could only diminish their ultimate value to future generations. Are we to sacrifice for short-term gain resources which, when properly administered, can benefit mankind for untold generations?

2. Industrial pollution and sewage wastes. A second broad concern centers on industrial pollution and pollution from inadequately treated sewage discharged in the Duluth-Superior area and along the North Shore of Lake Superior. Considerable evidence already points to serious pollution of the St. Louis River and Bay by wood products industries. Additional pollution by metal fabricating, beverage, and food products industries have reduced the

water quality of the St. Louis Bay to such a degree that it is now included in the list of chemically contaminated harbor areas of the Great Lakes by the Federal Water Pollution Control Administration.[2]

The label of inadequate sewage treatment can presently be applied to both the Duluth and Superior sewage treatment facilities. The low quality effluent from these municipal systems, combined with the previously cited industrial pollution and indiscriminate waste disposal by ships, have, we feel, brought the harbor area to a shocking level of pollution.

I will omit a paragraph which relates to a 1965 Minnesota water pollution control study, which, in essence, points out we studied the issue and little was accomplished at that time. That was 4 years ago.

Late in 1968 several area industries and municipalities received notice from the Minnesota Pollution Control Agency that improvements in sewage and waste disposal would be necessary on their part in order for them to comply with interstate water quality standards for the State of Minnesota. Included in the list of those notified were Duluth, Carlton, Scanlon, Two Harbors, and Floodwood. Also cited were Superwood Corporation, R. J. Reynolds Foods, Inc., and Fitger Brewing Co.[4] In the initial letter of the

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[2] Water Pollution Problems of the Great Lakes Area, p. 9. U.S.D.I., FWPCA Sept. 1966 (Rev. October 1967)

[4] Letter from R. D. Miller, Acting Chief, Section of Enforcement, M.P.C.A., February 3, 1969

Acting Chief, Section of Enforcement, the statement also included U. S. Steel plant, but a subsequent letter from Mr. Miller indicated their name is not included.

We sincerely hope that these industries and communities are currently in the process of meeting the required standards.

Dumping of taconite tailings from the Reserve Mining Company plant at Silver Bay is also of great concern. Reports have indicated that Republic Steel Corporation (co-owner with Armco Steel of the Reserve plant) has continually refused to comply with the Calumet Area Federal-State Enforcement Conference standards established in 1965 for the installation of antipollution control measures in its plant at 11600 Burley Avenue, Chicago, Illinois. Outdoor America, the Izaak Walton magazine, reports: "... Republic has not denied that it is polluting the Calumet River, and its attitude suggests that it will continue to do so as long as it chooses." [5]

We trust and I might add, that the attitude of Reserve Mining Company toward Lake Superior and its future is much more enlightened than the attitude of Republic Steel toward the Calumet River in Illinois. Yet our concern continues, for the original Interior Department Lake Superior report indicates in one of its concluding statements that, "One requirement of the Minnesota Pollution Control Agency permit /̲to Reserve Mining/ to discharge tailings into Lake Superior is violated in that there is 'material clouding or discoloration of the water at the surface' outside the prescribed permit area."[6]

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[5] Izaak Walton Magazine, March 1969.

Our question: "Is there or is there not a violation of the permit?" Whose evidence shall we accept?

3. Pesticides. We recognize the need to control insect pests of various kinds, both in agricultural enterprise and in protection of forest lands and also with regard to specific infestation in cities or in the countryside or threats to the public health. We are most concerned, however, with the effect the use of certain chemical pesticides has, either through runoff from adjacent lands or on direct application, on water resources such as those found in the Lake Superior Basin. Effects on fish life, on animal life, and eventually on man, are crucial. Our primary concern is with the chlorinated hydrocarbon pesticides such as DDT -- those which persist even as they disperse -- of which the long-term effects on man and nature are still basically unknown. We concur with Rachel Carson's observation, and reiterate her question in the closing sentence of this quote from Silent Spring:

> "The fisheries of fresh and salt water are a resource of great importance, involving the interests and the welfare of a very large number of people. That they are now seriously threatened by the chemicals entering our waters can no longer be doubted. If we would divert to constructive research even a small fraction of the money spent each year on the development of ever more toxic sprays, we could find ways

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[6] Summary Report on Environmental Impacts of Taconite Waste Disposal in Lake Superior, Part I. U.S. Department of the Interior, December 1968, p. 26.

to use less dangerous materials and to keep poisons out of our waterways. When will the public become sufficiently aware of the facts to demand action?" [7]

4. Wastes from watercraft. To the extent that such action is still carried out, we are deeply concerned with the effect of bilge water pumping by lake and ocean ships, and with solid waste, garbage, and sewage disposal into Lake Superior or any of its bays and harbors from such ships, or by private pleasure craft. We are shocked to note in this respect that the U. S. Coast Guard Cutter WOODRUSH, operating out of Duluth, with a 47 man complement, provides for no adequate waste treatment system. [8]

If you will refer to Page 79 of the report of this conference, you will find that information.

5. Dredged materials. We also question the propriety of dumping dredged materials from ship channels directly into bays and harbors and, in some cases, the transfer of such materials from bay bottoms out into the lake for disposal.

6. Absentee corporate decisions. Finally, we express concern for a problem over which we have little or no local control or influence -- namely, the fact that crucial decisions which affect the future of the Lake Superior Basin, and perhaps even its continued existence as a prime source of freshwater, are increasingly being made by conglomerate corporations headquartered in Pittsburgh, San Francisco, Chicago, or other cities far removed from the lake

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[7] Rachel Carson, Silent Spring, Boston: Houghton Mifflin Co., 1962, p. 152.

[8] An Appraisal of Water Pollution in the Lake Superior Basin, U.S.D.I., FWPCA, April 1969, p. 79.

basin. For as citizens, we have no voice in decisions whose consequences may some day vitally affect our lives and the lives of future generations living on Lake Superior's shores.

We recognize many threats from pollution and contamination in the Lake Superior Basin. These have been all too briefly touched upon in this statement, and too rapidly. They range from concern for untreated sewage to chemical wastes, pesticides, and taconite tailings, among others. Existing problems prompt Duluth Chpater, Izaak Walton League, to propose the following recommendations as the concluding section of this statement:

Recommendations

1. The responsibility of each polluter for all forms of damage caused by his pollution should be effectively recognized and generally accepted. There should be no "right" to pollute. Indeed, it would be wiser to follow a policy which would require a manufacturer or producer of an objectionable substance to prove, first of all, that it is not harmful before he is granted a permit to release it into the environment.

2. The roles of all governmental authorities, local, State, and Federal, in pollution enforcement and regulation should be complementary and mutually supporting, and not competitive. At present, for example, the Minnesota Pollution Control Agency suggests that Reserve Mining is not violating its permits in the Lake Superior operation, yet the very action of convening this Conference seems to indicate a concern on the part of the U. S. Interior Department

that there might well exist violation of water quality standards for interstate waters.[9]

3. Where the statistics are clear as to water quality standards, violators should be prosecuted to the fullest extent. With respect to pollution of the St. Louis River and Bay area, the League believes the State and local authorities have moved much too slowly against those whose actions violate the regulations established for environmental pollution control, and this is the one that is so difficult to measure.

4. The League recommends that agencies which set water quality standards for personal and industrial use consider qualities often impossible to measure in dollars and cents, yet values which are absolutely essential to man's continued existence on earth -- prime among these being aesthetic factors and crucial ecological interrelationships which exist in every unpolluted watercourse. Ecology and aesthetics are of immeasurable value. We must manage our resources with an understanding of ecological relationships much more firmly in mind than it has ever been to date.

5. We are asking that water quality standards for the Lake Superior Basin be maintained at the highest level, not compromised. Standards for thermal pollution, radioactive materials discharges, pesticides, chemical additives, sediment, and sewage effluent discharges should all be stringently enforced. Maintaining high standards at this time will assure citizens of this lake basin

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[9] See Page 797 above.

that new industrial, municipal, or private development along the lake shore must meet high standards of water quality. This action, if taken earlier, would have eliminated the painful sort of dilemma which we now face.

6. Citizens must stand up and speak out for a livable environment. It is possible to have jobs and also to husband our resources for generations yet unborn. Let us not be otherwise convinced.

Thank you, gentlemen.

(Applause.)

MR. DOMINICK: Thank you very much.

Our final witness will be Grant Merritt. Following Mr. Merritt we will close out for the evening and be back at 9 o'clock in the morning.

Mr. Merritt.

MR. MERRITT: Mr. Chairman, we have been here for 9½ or 10 hours. I would respectfully request that we adjourn until tomorrow morning at 9 o'clock, or even earlier. It has been a long, tiring day; I would prefer if at all possible to go on the first thing in the morning.

MR. DOMINICK: Mr. Merritt, it has been a tiring day for all of us. We still have a great number of witnesses to hear from tomorrow, and we would like to hear from you now, please.

MR. MERRITT: I would again renew my request, Mr. Chairman. I do have a rather lengthy statement to present. I think in view of the hour, in view of the time the reporter has been here, the official reporter and the other reporter present, that we ought to have some consideration for the two reporters as well as the rest of us. We have been here for some 9½ to 10 hours, and I would request the Minnesota Delegation, if at all possible, to give us this consideration as well as the consideration for the others.

MR. BADALICH: Mr. Merritt, I appreciate your concern. I have to allude to the fact that I have another 15 witnesses who want to be heard and they would like to talk anywhere from 10 to 15 minutes, plus I have eight or nine other statements that I want to enter for the record. This is tiring for us. And I would like to see this conference concluded as soon as possible, if at all possible by tomorrow evening.

MR. MERRITT: I can confine my remarks to 20 minutes in the morning, if that would facilitate the conference, and I would prefer to do that, if at all possible.

MR. DOMINICK: I think we should go ahead with the schedule we planned and hear from you this evening and then proceed with the State of Michigan tomorrow.

MR. MERRITT: Then, in that event, Mr. Chairman, I would yield to a couple other gentlemen who are on the agenda who are prepared to give shorter statements this evening.

MR. DOMINICK: And you withdraw your request to testify at this time?

MR. MERRITT: No, I do not withdraw my request to testify. I would expect to be on the agenda tomorrow sometime. Anytime during the day is perfectly all right.

MR. DOMINICK: This will create intolerable confusion. We have a list that is established. Let's proceed in an orderly manner with that list.

MR. MERRITT: I don't think there will be any confusion. I don't think it would be any problem.

MR. PEGORS: My name is John Pegors. I have been asked to submit three statements for three different organizations. Representatives of these organizations are unable to be present. Their presentations will be of such a nature that they would satisfactorily fill up the time that you wish to use, to give to Mr. Merritt. It would not create an intolerable confusion. The agenda Mr. Badalich gave to me last night has been altered, and I would be more than happy to submit these statements.

MR. DOMINICK: All right, we will revise the list.

Mr. Merritt, you can come in at the end of that list and we will hear from you.

MR. MERRITT: Thank you very much, Mr. Chairman.

MR. BADALICH: Will you identify yourself and also identify the group you are speaking for, respectively.

Donald Andrews

STATEMENT OF DONALD ANDREWS
VICE-CHAIRMAN, MINNESOTA
ENVIRONMENTAL DEFENSE COUNCIL
ST. CLOUD, MINNESOTA (read by John Pegors)

MR. PEGORS: Thank you, Mr. Commissioner, and Mr. Badalich.

My name is John Pegors.

At this time I would like to read a statement on behalf of Mr. Donald Andrews of 1515 Eighth Avenue North, St. Cloud, Minnesota. He was not present today.

MR. DOMINICK: So we may clarify this, are you presenting a statement on your own behalf?

MR. PEGORS: This is for a gentlemen who was not able to be here today.

MR. DOMINICK: If he is not present, we will place it in the record, and if you have any other statements, we will then place those in the record.

(The above-mentioned statement follows.)

Donald Andrews

My name is Don Andrews. I live at 1515 8th Avenue North, St. Cloud, Minnesota. In making this statement today I wish to represent the missing, the unheard from majority. I am representing the millions of people who are interested in Lake Superior but who have to work every day. We are the contributors to this country's ever increasing gross national product. We cannot take time off once or twice a month to attend hearings. While we are contributing to the prosperity of this country we are paying taxes and we expect that our Pollution Agency will enforce the laws and protect our rights.

Among the missing today will be my son-in-law just starting in the insurance business. He has to sell $500.00 worth of commissions each month or he is out. No, he can't be here today.

Then there is my neighbor who has not heard the words "economically feasible . He would not be nominated to a Pollution Control Agency because he has never been connected with an establishment which pours its wastes into our waters. No, he works each day and cannot be here.

My son goes to the University of Minnesota. He has to study quite a bit to keep his grades up. But should he have to attend this hearing? You can be sure he wants to see Lake Superior as it was in the past. Do we not have a moral obligation to leave this lake as it was when we first saw it? Can you really blame the younger generation for being upset, for rioting, etc.? The young men face draft into a war we are not trying to win and they are inheriting the mistakes of their fathers in the indiscriminate use of pesticides and the most thorough destruction of the country's most vital freshwater.

The men we have stationed in Viet Nam, cannot be here. But what are they putting their lives in jeopardy for? Does not the State of Minnesota owe these men the right to come home to a country where the water is still pure -- where fishing and other recreation can be enjoyed? When permits for discharging wastes are permitted the entire Nation suffers.

I would like to ask the conferees to stand on the shore of Lake Superior at Silver Bay. Look at the water good. Without a doubt this is pollution. There is a great change in the water -- in the color. You can see it. Wastes are being discharged.

What about the fish? Is there any change in the ecology here? Just try keeping a goldfish alive in a bowl while circulating sand through the water. Can you imagine a fish running this stuff through its gills to get oxygen?

Another disgrace to this country and to Minnesota is the harbor at Duluth. It has been considered unsafe to wade in this water for over 40 years. And it gets worse.

I am pleased that this Federal conference has been called and I hope that you will remember the unheard majority who are willing to pay more taxes for pollution abatement, and pay more for the product if necessary. We are happy that the Federal

Government came up with the Water Quality Act of 1965, otherwise we would be just where we were in 1965. I urge the Federal Water Pollution Agency to enforce the laws in this case and save Lake Superior for the citizens of the United States.

MR. PEGORS: In that event, I would like to present a statement on behalf of the Minnesota Environmental Defense Council. I am vice-chairman of this organization. I have copies of this statement for you at this time.

MR. DOMINICK: And you are representing that Council here?

MR. PEGORS: Yes.

MR. DOMINICK: Fine.

MR. PEGORS: The Minnesota Environmental Defense Council is an organization of Minnesota groups interested in those problems which bear on the environment in the State of Minnesota.

The Minnesota Environmental Defense Council has among its active supporters the Southern Minnesota Conservation Association, Minnesota Conservation Federation, League of Women Voters of Minnesota, Minnesota Federation of Women's Clubs, Community Wildlife Club, Inc., of St. Cloud, Clearwater Sportsmen's Club, Clear Air-Clean Water Unlimited, and Minnesota Environmental Control Citizen's Association.

The Defense Council was organized to coordinate activities in the areas of environmental enhancement. Our interest in Lake Superior is the need for immediate activity in the abatement of the pollution of this Nation's greatest lake. We believe that the strength of our Nation's future depends on the wise use of its resources. And the present policy of destroying our resources to create or maintain jobs is very shortsighted.

The policy I refer to is the matter of dumping wastes into Lake Superior by Reserve Mining. This is simply a matter of this company making a profit at the expense of the citizens of Minnesota and of the United States.

The question of whether there is pollution or not is also irrelevant. There is a definite material clouding of the water below the plant. This discoloration has an effect on the ecology of the surrounding area. What will be the effect when this plant expands, as all industry does, as so often happens in the case of industry? What we have here is a potential threat to the very life of this lake.

The MEDC strongly recommends the enforcement of the present laws. Present studies show that this company has violated the present permit. The conferees are urged to require on-land deposit of taconite wastes.

Another potential threat to the water quality of Lake Superior is the recently proposed gaseous diffusion plant at Knife River. The proposed plant would be the source of enormous amounts of heated wastewater as well as radioactive isotopes from the nuclear reactors necessary to operate the plant processes. Discharge of these thermal and radioactive wastes would cause severe damage to the ecological systems in the Knife River area of Lake Superior.

John Pegors

Other sources of pollution affecting the ecological balances of Lake Superior include the siltation of the Nemadji River, heavy industrial and municipal sewage wastes from the St. Louis River, the Cities of Duluth and Two Harbors, and the many resort facilities located along the lake shore. In addition, to these sources of damage to the Lake Superior ecosystem, we must acknowledge the harm from the pesticides, especially the chlorinated hydrocarbons, used so indiscriminately. Strong evidence indicates the gradual elimination of our American Bald Eagle populations caused by metabolic dysfunctions due to chlorinated hydrocarbon concentrations in the fish food of these birds. A halt to the use of these powerful biocides should be a principal objective of the conferees.

Evidence continues to mount showing the health and welfare of our citizens is seriously affected by the pollution of this great natural resource, Lake Superior. We are sick and tired of the never-ending studies that are proposed. The time for action to halt further pollution of Lake Superior is at hand and the distinguished conferees should take that necessary action. Enforce the law, gentlemen.

Then, Mr. Chairman, I would also like to submit the statement for an organization known as Clear Air-Clear Water, and I will submit copies for the conferees.

John Pegors

Lake Superior is a natural resource that the citizens of Minnesota must protect from exploitation and premature aging through use of the lake as a dumping ground for by-products--

MR. DOMINICK: Excuse me. Would you identify your relationship?

MR. PEGORS: Yes. I am sorry. I beg your pardon.

My name is John Pegors. I am President of Clear Air-Clear Water. It is a citizens' organization comprised mainly of residents in the Mississippi Valley and the St. Croix Valley. The membership ranges from approximately the St. Cloud area down to the lower end of the Mississippi River at Winona and in the St. Croix Valley as far north as Danbury, Wisconsin.

MR. DOMINICK: Very well, you may proceed.

MR. PEGORS: Thank you.

Lake Superior is a natural resource the citizens of Minnesota must protect from exploitation and premature aging through use of the lake as a dumping ground for by-products of various industrial technological processes. The grave condition of Lake Erie, prematurely aged 15,000 years since the turn of this Century, by man's disregard for ecological systems and natural processes, should serve as a crystal clear warning to us not to further jeopardize Lake Superior. Lake Michigan is now entering a crisis which conceivably could find us faced with another gravely injured member of the Great Lakes family. We have the knowledge to protect Lake Superior from a fate similar to that of Lakes Erie and Michigan. The question we must answer at this Conference is: Do we have the courage and the wisdom to save Lake Superior?

John Pegors

Clear Air-Clear Water Unlimited, urges the distinguiseed confereed to recommend all action necessary to protect Lake Superior from further contamination by industrial, municipal, manufacturing, mining, shipping, and private wastes. Lake Superior should not be used as a dumping ground for taconite wastes, hence a natural resource subsidy to the mining industry.

Taconite tailings are harmful to aquatic life and constitute a threat to the intricate balances found in the ecosystems of the lake. Ample evidence exists that the wastes from Reserve Mining Company have caused deleterious effects on various fish and fauna of the lake. Violations of the original permit to Reserve Mining Company have occurred. These violations are good and sufficient reason for complete cessation of dumping of taconite wastes in Lake Superior. Applicable Federal water quality standards for Lake Superior have also been violated by Reserve Mining.

We respectfully urge the conferees to require the adoption of the fastest possible timetable for cessation of all discharge of wastes of all kinds by Reserve Mining Company.

We urge the distinguished conferees to take every necessary measure to protect Lake Superior from the potential threat of discharge of any radioactive and thermal discharges from any installations that might be constructed and operated in the Lake Superior Basin. The proposed gaseous diffusion plant at Knife River would be one such source of radioactive and thermal wastes. The greatly elevated order of magnitude of toxicity of these pollutants should be anticipated by the conferees and all necessary preventive measures taken to assure that the water quality of the lake is preserved. The United States Atomic Energy Commission should not be permitted to assist in the establishment of any levels of discharge of radioactive wastes into Lake Superior, as is noted in the document "An Appraisal of Water Pollution in the Lake Superior Basin, April 1969," page 106.

We respectfully urge the enforcement of all existing and applicable water quality standards for Lake Superior. Delays for additional surveys, studies, and appraisals of the health of Lake Superior are superfluous.

In addition, Mr. Chairman, I have a short statement I have been asked to present for the Rice Area Sportsman's Club. I believe I have submitted copies of this to you earlier.

MR. DOMINICK: That will be received for the record.

(The above-mentioned statement follows.)

RICE AREA SPORTSMAN'S CLUB

Rice, Minnesota

Our names are John Clark and Elwood Anderson, co-chariman of the anti-pollution committee and we would like to make a statement on behalf of the Rice Area Sportsman's Club, as regard to the continued use of Lake Superior for the dumping of taconite tailings.

Rice Area Sportsman's Club

1. We believe that the Great Lakes and their watersheds belong to all people of the United States and any use should be for the benefit of the entire population.

2. We believe that no person, group of persons or corporation, should have the right to exploit or destroy these great water courses for profit.

3. We believe that the waters of our land should be passed on to succeeding generations as pure and wholesome as they were before man began to use them.

We are not technically trained experts but make this statement as interested citizens who appreciate the value of this great reservoir of fine water, both locally and nationally, and want to take no chance that it will be destroyed.

We have read the study of the Regional Coordinator of U.M.W.G.L.A., we have read many other papers and studies on the dumping of industrial waste and taconite tailings into Lake Superior, we have heard many speakers on this subject, and have come to the same conclusions as the United Northern Sportsman of Duluth, Duluth, Minnesota, and would like to repeat their summary as follows:

1. It is an undisputed fact the St. Louis River, the first major tributary to the lake, is being polluted by municipal, industrial, and natural wastes. We want the sources of pollution identified, and we see no reason for further delay in implementing a

vigorous and prompt program of pollution correction and control immediately.

2. Municipal, industrial, and marine wastes are adding their contaminating influence daily to the Duluth-Superior Harbor. It is our desire to restore the esthetic value of a clean and fresh smelling body of water (to add to the value of our cities very fine cultural, recreational, and educational facilities) we must identify the sources of pollution and call upon our State and Federal officials and agency to use every means available to either stop or curtail this insidious poisoning of what could well be Duluth and Superior's finest resource.

3. Many private cabins or homes are located so close to the shore, or have disposal systems so ineffective that seepage is directly polluting the lake or ground water sources. We want an ambitious program instituted by the State Water Pollution Control Agency as soon as possible to remedy this situation.

4. If the proposed location of a nuclear breeder plant on Lake Superior would have any adverse effect on the quality of the water in the lake, we would be opposed to it. All questions of feasibility add possible constructive use of the heat generated by such an installation should be answered in advance and not after the construction of such an industry.

5. We have consistently opposed the disposal of taconite tailings in Lake Superior. We believe this practice should be stopped and an alternate method of disposal employed. Until such

changes are made, the State should enforce the present permit which specifically prohibits any material clouding of the lake and grant no liberalization of same beyond the permit limits. Any statement that this company cannot operate unless allowed to dispose of waste in Lake Superior is debatable because other companies are doing it and competing successfully. We also call upon the U. S. Army Corps of Engineers to require on land disposal of tailings at Silver Bay as recommended in the U. S. Department of Interior report dated December 31, 1968.

6. Siltation is a major contributing factor to pollution. The problem areas should be pinpointed and immediate steps taken to institute sound soil conservation practices.

7. All other sources of pollution around the Lake, either from feeder streams, municipal, industrial or private uses, deserve immediate determined corrective action.

8. Finally, we urge a review of the water quality standards adopted for Lake Superior in that they be strengthened to prohibit all thermal, nuclear and pesticide pollution, and to tighten the standards relating to siltation, toxic metals and shipboard waste.

In conclusion, we believe that sufficient studies have been made and these studies prove that the lake is becoming more polluted and that if this pollution is to be remedied, all sources of pollution must be stopped immediately.

Sincerely,

/s/ John A. Clark
John A. Clark

/s/ Elwood Anderson
Elwood Anderson

MR. DOMINICK: Mr. Pegors, if you will suspend there, I think we have reached the limit of our endurance today.

I would ask that all witnesses in the future try to confine their remarks to new information, if possible, and that we avoid wherever possible the duplication and the repetition of testimony.

Further, I would ask that where witnesses have submitted statements but are not personally present to offer them, these statements will be placed in the record.

We will suspend the conference here and return at 9 o'clock tomorrow morning. I believe we have another meeting place for the conference.

Is that correct?

MR. BRYSON: Yes. It is downstairs in the Moorish Room. It is on the first floor.

MR. DOMINICK: I think the Rotarians are moving us out of here tomorrow, so we will meet downstairs in the Moorish Room.

Thank you very much for your patience.

(Whereupon, at 6:50 p.m., the conference adjourned until Thursday, May 15, 1969, at 9:00 a.m.).

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